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SCIENTIFIC MANPOWER UTILIZATION. HEARINGS ON S. 430. AND S. 467. JANUARY 24-27. MARCH 29-30. 1967.

SENATE COMMITTEE ON LABOR AND PUBLIC WELFARE

PUB DATE 67

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THE PURPOSE OF BILL S. 430. "SCIENTIFIC MANPOWER UTILIZATION ACT OF 1967." IS TO FACILITATE AND ENCOURAGE THE UTILIZATION OF THE SCIENTIFIC. ENGINEERING. AND TECHNICAL RESOURCES OF THE NATION IN MEETING URGENT NATIONAL AND LOCAL PROBLEMS BY PROMOTING THE APPLICATION OF SYSTEMS ANALYSIS AND SYSTEMS ENGINEERING TO PROBLEMS IN THE AREAS OF EDUCATION. UNEMPLOYMENT. WELFARE. CRIME. JUVENILE DELINQUENCY. AIR POLLUTION. HOUSING. TRANSPORTATION. AND WASTE DISPOSAL. THE SECRETARY OF LABOR WILL CARRY OUT THE PURPOSES OF THE ACT BY MAKING APPROPRIATE GRANTS TO STATES AND BY ENTERING INTO APPROPRIATE ARRANGEMENTS WITH UNIVERSITIES OR OTHER PUBLIC OR PRIVATE INSTITUTIONS OR ORGANIZATIONS. BILL S. 467 ESTABLISHES A NATIONAL COMMISSION ON PUBLIC MANAGEMENT COMPOSED OF A CHAIRMAN. VICE CHAIRMAN. AND 11 OTHER APPOINTED MEMBERS TO BE CONCERNED WITH DEVELOPING. DISSEMINATING. AND IMPLEMENTING MODERN MANAGEMENT TECHNOLOGY AND ANALYZING THE SYSTEMS INTERRELATIONSHIPS INVOLVED IN PUBLIC BUSINESS PROBLEMS. TEXT OF THE BILLS. THE TESTIMONY OF CONGRESSIONAL WITNESSES. AND LITERATURE RELATING TO THE SUBJECT ARE INCLUDED. (PS)

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SCIENTIFIC MANPOWER UTILIZATION, 1967

HEARINGS

BEFORE THE

SPECIAL SUBCOMMITTEE ON THE UTILIZATION OF SCIENTIFIC MANPOWER

OF THE

COMMITTEE ON LABOR AND PUBLIC WELFARE

UNITED STATES SENATE

NINETIETH CONGRESS

FIRST SESSION

ON

S. 430

A BILL TO MOBILIZE AND UTILIZE THE SCIENTIFIC AND ENGINEERING MANPOWER OF THE NATION TO EMPLOY SYSTEMS ANALYSIS AND SYSTEMS ENGINEERING TO HELP TO FULLY EMPLOY THE NATION'S MANPOWER RESOURCES TO SOLVE NATIONAL PROBLEMS

S. 467

A BILL TO PROVIDE FOR A STUDY WITH RESPECT TO THE UTILIZATION OF SYSTEMS ANALYSIS AND MANAGEMENT TECHNIQUES IN DEALING WITH PROBLEMS RELATING TO UNEMPLOYMENT, PUBLIC WELFARE, EDUCATION, AND SIMILAR PROBLEMS

JANUARY 24, 25, 26, 27; MARCH 29, AND 30, 1967

Printed for the use of the Committee on Labor and Public Welfare

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SCIENTIFIC MANPOWER UTILIZATION, 1967

TUESDAY, JANUARY 24, 1967

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON SCIENTIFIC MANPOWER
UTILIZATION OF THE COMMITTEE ON
LABOR AND PUBLIC WELFARE,
Washington D.C.

The special subcommittee met at 9:30 a.m., pursuant to call, in room 4232, Senate Office Building, Senator Gaylord Nelson (chairman of the special subcommittee) presiding.

Present: Senators Nelson (presiding), Javits, and Dominick.

Committee staff members present: William Spring, special counsel to the subcommittee.

Senator NELSON. The special subcommittee will be in order.

We have as witnesses this morning Congressman Bradford Morse of Massachusetts; Karl Harr, Jr., president, Aerospace Industries Association of America; and Dr. E. R. Roberts, vice president, development, Aero-Jet General Corp., El Monte, Calif.

On June 2 through June 10, and on July 22, 1965, Senator Clark and I conducted hearings on the impact of Federal research and development policies on scientific and technical manpower.

Out of those hearings we developed and drafted S. 2662, a bill to mobilize and utilize the scientific and engineering manpower of the Nation, to employ systems analysis and systems engineering to help fully employ the Nation's manpower resources to solve national problems.

I conducted hearings on this bill in Los Angeles, Calif., on November 19, 1965. On that occasion we heard from the four corporations that did the studies for the State of California.

On May 17 and 18, 1966, we conducted further hearings here in Washington and heard from the various Federal agencies.

On August 12, 1966, Senator Scott introduced a bill, and on the same day, I believe, Congressman Morse introduced a bill in the House.

I discussed this subject sometime last year with Congressman Morse and with Senator Dominick and suggested the idea that perhaps we could work out a hearing and a bipartisan bill that utilized this concept. These hearings are a consequence of those discussions at that time.

At this point in the record, without objection, I order the text of the bills printed.

(The bills, S. 430 and S. 467, follow:)

90TH CONGRESS
1ST SESSION

S. 430

IN THE SENATE OF THE UNITED STATES

JANUARY 17 (legislative day, JANUARY 12), 1967

Mr. NELSON (for himself, Mr. CLARK, and Mr. RANDOLPH) introduced the following bill; which was read twice and referred to the Committee on Labor and Public Welfare

A BILL

To mobilize and utilize the scientific and engineering manpower of the Nation to employ systems analysis and systems engineering to help to fully employ the Nation's manpower resources to solve national problems.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Scientific Manpower Utilization Act of 1967".

SEC. 2. It is the purpose of this Act to facilitate and encourage the utilization of the scientific, engineering, and technical resources of the Nation in meeting urgent problems facing the Nation or localities within the Nation, by promoting the application of systems analysis and systems engi-

neering approaches to such problems. The problems referred to in the preceding sentence include, but are not limited to, problems in the area of education, unemployment, welfare, crime, juvenile delinquency, air pollution, housing, transportation, and waste disposal.

SEC. 3. The Secretary of Labor (hereinafter referred to as the "Secretary") shall carry out the purposes of this Act by—

(1) making appropriate grants to States, and

(2) by entering into appropriate arrangements (whether through grants or contracts, or through other agreements) with universities or other public or private institutions or organizations,

for the purpose of causing the systems analysis and systems engineering approaches to be applied to national or local problems of types which the Secretary, by regulations, designates as being within the purview of this Act.

SEC. 4. (a) Any grant made under section 3 to a State shall be used only for the purpose for which the grant was made, and may be used by the State for such purpose directly, or through the State's entering into appropriate arrangements for the carrying out of such purpose (whether through grants or contracts, or through other agreements) with universities or other public or private institutions or organizations.

(b) No grant under this Act shall be made to a State unless the Secretary finds that—

(1) the knowledge and experience expected to be gained from the employment of such grant would have substantial relevance to problems within the purview of this Act which exist in other States;

(2) the State has presented a plan setting forth in detail the purposes for and manner in which such grant is to be used, together with the objectives expected to be achieved from the use of such grant;

(3) the State has designated an officer or agency of the State who has responsibility and authority for the administration of the program in which such grant is to be employed; and

(4) the State agrees fully to make available to the Federal Government and to other States (and political subdivisions thereof) data and information regarding the employment of such grant and the findings and results stemming therefrom.

(c) There shall not be granted to any State under this Act amounts the aggregate of which exceed 20 per centum of the aggregate of the amounts which have been appropriated to carry out this Act at the time amounts are granted to such State hereunder.

(d) Two or more States may combine to apply for one

or more grants jointly to carry out the purposes of the Act with respect to one or more of the problems which they have in common and which are within the purview of this Act, and in any such case, the provisions of subsection (b) shall be deemed to require the submission of a joint plan for the utilization of the grant and the designation of one or more officers or agencies having responsibility and authority to carry out the joint plan. Each State participating in such a joint plan shall be deemed, for purposes of subsection (c), to have received an amount equal to the amount produced by dividing the amount of the grant received to carry out such plan by the number of States participating in such plan.

SEC. 5. The Secretary, in awarding grants to States and in entering into arrangements with universities or other public or private institutions or organizations, shall follow procedures established by him for the purpose of assuring that the grants or other expenditures made to carry out the purposes of this Act will be equitably distributed among the various major geographic regions of the Nation.

SEC. 6. For the purpose of making the grants and entering into the other arrangements provided under section 3 of this Act, there is hereby authorized to be appropriated, without fiscal year limitation, not more than $125,000,000.

90TH CONGRESS
1ST SESSION

S. 467

IN THE SENATE OF THE UNITED STATES

JANUARY 18 (legislative day, JANUARY 12), 1967

Mr. SCOTT (for himself, Mr. ALLOTT, Mr. BENNETT, Mr. CASE, Mr. DOMINICK, Mr. FANNIN, Mr. FONG, Mr. GRIFFIN, Mr. JAVITS, Mr. JORDAN of Idaho, Mr. KUCHEL, Mr. MORTON, Mr. MURPHY, Mr. PROUTY, and Mr. TOWER) introduced the following bill; which was read twice and referred to the Committee on Labor and Public Welfare

A BILL

To provide for a study with respect to the utilization of systems analysis and management techniques in dealing with problems relating to unemployment, public welfare, education, and similar problems.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

CREATION OF COMMISSION

SECTION 1. In order to study and recommend the manner in which modern systems analysis and management techniques may be utilized to resolve problems relating to unemployment, public welfare, education, and similar national and community problems in the nondefense sector,

there is hereby established a National Commission on Public Management (hereafter in this Act referred to as the "Commission"), under the general supervision and direction of the Secretary of Labor.

MEMBERSHIP OF THE COMMISSION

SEC. 2. The Commission shall be composed of a Chairman, a Vice Chairman, and eleven other members to be appointed by the President, by and with the advice and consent of the Senate. Members of the Commission shall be individuals concerned with the subject matter to be studied by the Commission, including individuals with experience derived from Government, business, the labor movement, or from teaching and research.

DUTIES OF THE CHAIRMAN AND VICE CHAIRMAN

SEC. 3. (a) The Chairman shall be responsible for calling regular quarterly meetings of the Commission and other special meetings as he deems necessary. The Chairman shall determine the time, place, and agenda for each regular or special meeting.

(b) The Vice Chairman shall act in the Chairman's absence.

QUORUM

SEC. 4. Seven members of the Commission shall constitute a quorum.

3

COMPENSATION OF MEMBERS OF THE COMMISSION

SEC. 5. (a) Members of the Commission, other than officers or employees of the Federal Government, shall receive compensation at the rate of $75 per diem while engaged in the actual performance of duties vested in the Commission, plus reimbursement for travel, subsistence, and other necessary expenses incurred by them in the performance of such duties.

(b) Any members of the Commission who are officers or employees of the Federal Government shall serve on the Commission without compensation, but such members shall be reimbursed for travel, subsistence, and other necessary expenses incurred by them in the performance of duties vested in the Commission.

STAFF

SEC. 6. (a) The Commission may appoint an Executive Director and such other personnel as it deems advisable. The Executive Director shall be the chief staff member of the Commission and shall be responsible to the Commission for the direction of its staff. The annual compensation for the Executive Director shall be $28,500.

(b) The Commission may procure temporary and intermittent services in accordance with section 3109 of title

5, United States Code, but at rates not to exceed $75 per day.

EXPENSES OF THE COMMISSION

SEC. 7. There are hereby authorized to be appropriated such sums as may be necessary, but not exceeding $500,000 in the aggregate, to carry out the provisions of this Act during the initial year of Commission operation.

DUTIES OF THE COMMISSION

SEC. 8. The Commission shall concern itself with the management of the public business and shall give attention to the development, dissemination, and implementation of modern management technology and analysis of the systems interrelationships involved in public business problems. The Commission, in the performance of its duties, shall:

(1) Develop information on the methodology of the systems approach and its applications.

(2) Analyze the possible application to public programs of such recognized management planning and control techniques as operations analysis and research, econometrics, mathematical programing and modeling, simulation, project management, and the utilization of automatic data processing devices and procedures for program control and information systems.

(3) Determine and categorize the national and

community problems to which the application of such techniques offers the greatest promise of solution.

(4) Assess the proper relationship between governmental and private investment to obtain the most effective application of the techniques involved.

(5) Make recommendations to the executive and legislative branches of the Federal Government regarding data requirements, management techniques, and systems interrelationships in the formulation of legislation.

(6) Conduct studies into unemployment, public welfare, education, and other specific problem areas and make recommendations.

(7) Schedule seminars, symposia, and prepare publications to expand public knowledge of and stimulate the use of modern management technology.

(8) Encourage the Nation's best talent in Government, labor, university, and private enterprise to study public management problems and to participate in the improvement and extension of modern management technologies and their application to public problems.

(9) Analyze alternative methods and make recommendations of Federal, State, and local governmental

support and encouragement of the application of modern management technology to public problems through the use of various contracting procedures, grants, loans, cost allowances, and tax incentives.

REPORTS

SEC. 9. (a) Within one year after the first meeting of the Commission it shall submit to the President and the Congress a preliminary report on its activities with particular emphasis on the plan for the study and investigation provided for in section 8 and any activities undertaken to carry out such plan, including an estimated budget for the remainder of the life of the Commission.

(b) Within thirty months after such first meeting the Commission shall submit to the President and the Congress a final report on its study and investigation which shall include its recommendations and such proposals for legislation and administrative action as may be necessary to carry out its recommendations.

(c) In addition to the preliminary report and final report required by this section, the Commission may publish such interim reports as it may determine, including but not limited to consultants' reports, transcripts of testimony, seminar reports, and other Commission findings.

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POWERS OF THE COMMISSION

SEC. 10. (a) The Commission or, on the authorization of the Commission, any subcommittee or member thereof, may, for the purpose of carrying out the provisions of this Act, hold such hearings and sit and act at such times and places, administer such oaths, and require, by subpena or otherwise, the attendance and testimony of such witnesses and the production of such books, records, correspondence, memorandums, papers, and documents as the Commission or such subcommittee or member may deem advisable. Subpenas may be issued under the signature of the Chairman of the Commission, of such subcommittee, or any duly designated member, and may be served by any person designated by such Chairman or member. The provisions of section 102 to 104, inclusive, of the Revised Statutes (U.S.C., title 2, secs. 192–194), shall apply in the case of any failure of any witness to comply with any subpena or to testify when summoned under authority of this section.

(b) The Commission is authorized to secure directly from any executive department, bureau, agency, board, commission, office, independent establishment, or instrumentality information, suggestions, estimates, and statistics for the purpose of this Act; and each such department, bureau,

agency, board, commission, office, establishment, or instrumentality is authorized and directed to furnish such information, suggestions, estimates, and statistics directly to the Commission, upon request made by the Chairman.

(c) The Commission is authorized to hold seminars or informal conferences as it deems appropriate to provide a forum for discussion of the application of modern systems analysis and management techniques to the solution of national community problems.

TERMINATION

SEC. 11. On the sixtieth day after the date of its submission of its final report to the President, the Commission shall terminate and all offices and employment therein shall expire.

Senator NELSON. Our first witness this morning will be Congressman Bradford Morse.

STATEMENT OF HON. F. BRADFORD MORSE, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MASSACHUSETTS

Mr. MORSE. Thank you, Mr. Chairman. I am indeed grateful to you for permitting me to appear before your subcommittee this morning.

I certainly want to commend you on the initiative which you have taken in introducing S. 430 and in scheduling these important hearings, which demonstrate your determination to find an effective solution to the intensifying national economic and social problems which face us.

I think there is great merit in your approach to the utilization of the scientific manpower which has been developed in our space and defense programs, for the solution of some of our nondefense, nonspace public problems.

Therefore, I am particularly grateful for this opportunity to discuss the approach we have taken in the House and that some of our colleagues in the Senate have taken to achieve the same goal, namely, the application of modern management techniques to the effective solution of these public problems.

Last August more than 40 of my Republican colleagues joined me in introducing legislation to create a National Commission on Public Management. Briefly, the Commission would be charged with the mandate to determine the applicability of modern management techniques, and to help develop specific recommendations and programs for individual problem areas.

Senator NELSON. That is the bill that was introduced on this side also and which is before this committee?

Mr. MORSE. It is slightly different. The bill which has been introduced in the Senate this year, Mr. Chairman, has a few modifications which I will discuss later on. It is essentially the same concept.

Designed to be a working, rather than a figurehead commission, the public management body would produce a report after 1 year on its progress to date and its work plan for the remaining 18 months of its life. There is a 2½-year life contemplated by the bill. Among its specific tasks would be to assess the relative merits of various financing techniques.

Senator NELSON. Do you discuss the membership of that committee?

Mr. MORSE. I do in a moment, Mr. Chairman.

Rather than take the time of the committee, I would ask to submit for your record a copy of my current bill, which was introduced in the 90th Congress, H.R. 20, and copies of the statements which I have made on the floor of the House discussing the Commission proposal in detail.

Senator NELSON. Your bill and your remarks will be printed in full in the record.

(The bill and remarks referred to follow:)

[H.R. 20, 90th Cong., 1st sess.]

A BILL To establish a National Commission on Public Management, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

CREATION OF COMMISSION

SECTION 1. In order to study and recommend the manner in which modern systems analysis and management techniques may be utilized to resolve national and community problems in the nondefense sector there is hereby established a National Commission on Public Management (hereafter in this Act referred to as the "Commission").

MEMBERSHIP OF THE COMMISSION

SEC. 2. The Commission shall be composed of a Chairman, a Vice Chairman, and eleven other members. The Chairman, Vice Chairman, and seven other members are to be appointed by the President, by and with the advice and consent of the Senate. The Commission shall include two Members of the Senate to be appointed by the President of the Senate and two Members of the House of Representatives to be appointed by the Speaker of the House of Representatives. Members of the Commission shall be individuals concerned with the subject matter to be studied by the Commission, including individuals with experience derived from government, business, the labor movement, or from teaching and research.

DUTIES OF THE CHAIRMAN AND VICE CHAIRMAN

SEC. 3. (a) The Chairman shall be responsible for calling regular quarterly meetings of the Commission and other special meetings as he deems necessary. The Chairman shall determine the time, place, and agenda for each regular or special meeting.

(b) The Vice Chairman shall act in the Chairman's absence.

QUORUM

SEC. 4. Seven members of the Commission shall constitute a quorum.

COMPENSATION OF MEMBERS OF THE COMMISSION

SEC. 5. (a) Members of the Commission, other than officers or employees of the Federal Government, shall receive compensation at the rate of $100 per diem while engaged in the actual performance of duties vested in the Commission, plus reimbursement for travel, subsistence, and other necessary expenses incurred by them in the performance of such duties.

(b) Any members of the Commission who are officers or employees of the Federal Government shall serve on the Commission without compensation, but such members shall be reimbursed for travel, subsistence, and other necessary expenses incurred by them in the performance of duties vested in the Commission.

STAFF

SEC. 6. (a) The Commission may appoint an Executive Director and such other personnel as it deems advisable. The Executive Director shall be the chief staff member of the Commission and shall be responsible to the Commission for the direction of its staff. The annual compensation for the Executive Director shall be $28,500.

(b) The Commission may procure, without regard to the civil service laws or the Classification Act of 1949, as amended, temporary and intermittent services to the same extent as is authorized by section 15 of the Administrative Expenses Act of 1946, but at rates not to exceed $75 per day.

EXPENSES OF THE COMMISSION

SEC. 7. There are hereby authorized to be appropriated such sums as may be necessary, but not exceeding $200,000 in the aggregate, to carry out the provisions of this Act during the initial year of Commission operation.

DUTIES OF THE COMMISSION

SEC. 8. (a) The Commission shall concern itself with the management of the public business and shall give attention to the development, dissemination, and implementation of modern management technology and the analysis of the systems interrelationships involved in public business problems. The Commission, in the performance of its duties, shall:

(1) Develop information on the methodology of the systems approach and its applications.

(2) Analyze the possible application to public programs of such recognized management planning and control techniques as operations analysis and research, econometrics, mathematical programing and modeling, simulation, projects management, and the utilization of automatic data processing devices and procedures for program control and information systems.

(3) Determine and categorize the national and community problems to which the application of such techniques offers the greatest promise of solution.

(4) Assess the proper relationship between governmental and private investment to obtain the most effective application of the techniques involved.

(5) Make recommendations to the executive and legislative branches of the Federal Government regarding data requirements, management techniques and systems interrelationships in the formulation of legislation.

(6) Conduct studies into specific problem areas and make recommendations.

(7) Schedule seminars, symposia and prepare publications to expand public knowledge of and stimulate the use of modern management technology.

(8) Encourage the Nation's best talent in government, labor, university and private enterprise to study public management problems and to participate in the improvement and extension of modern management technologies and their application to public problems.

(9) Analyze alternative methods and make recommendations of Federal, State, and local governmental support and encouragement of the application of modern management technology to public problems through the use of various contracting procedures, grants, loans, cost allowances, and tax incentives.

REPORTS

SEC. 9. (a) Within one year after the first meeting of the Commission it shall submit to the President and the Congress a preliminary report on its activities with particular emphasis on the plan for the study and investigation provided for in section 8 and any activities undertaken to carry out such plan, including an estimated budget for the remainder of the life of the Commission.

(b) Within thirty months after such first meeting the Commission shall submit to the President and the Congress a final report on its study and investigation which shall include its recommendations and such proposals for legislation and administrative action as may be necessary to carry out its recommendations.

(c) In addition to the preliminary report and final report required by this section, the Commission may publish such interim reports as it may determine, including but not limited to consultants' reports, transcripts of testimony, seminar reports, and other Commission findings.

POWERS OF THE COMMISSION

SEC. 10. (a) The Commission or, on the authorization of the Commission, any subcommittee or member thereof, may, for the purpose of carrying out the provisions of this Act, hold such hearings and sit and act at such times and places, administer such oaths, and require, by subpena or otherwise, the attendance and testimony of such witnesses and the production of such books, records, correspondence, memorandums, papers, and documents as the Commission or such subcommittee or member may deem advisable. Subpena may be

issued under the signature of the Chairman of the Commission, of such subcommittee, or any duly designated member, and may be served by any person designated by such Chairman or member. The provisions of sections 102 to 104, inclusive, of the Revised Statutes (2 U.S.C. 192–194), shall apply in the case of any failure of any witness to comply with any subpena or to testify when summoned under authority of this section.

(b) The Commission is authorized to secure directly from any executive department, bureau, agency, board, commission, office, independent establishment, or instrumentality information, suggestions, estimates, and statistics for the purpose of this Act; and each such department, bureau, agency, board, commission, office, establishment, or instrumentality is authorized and directed to furnish such information, suggestions, estimates, and statistics directly to the Commission, upon request made by the Chairman.

(c) The Commission is authorized to hold seminars or informal conferences as it deems appropriate to provide a forum for discussion of the application of modern systems analysis and management techniques to the solution of national community problems.

TERMINATION

SEC. 11. On the sixtieth day after the date of its submission of its final report to the President, the Commission shall terminate and all offices and employment therein shall expire.

[From the Congressional Record, Aug. 25, 1966]

MANAGING THE PUBLIC BUSINESS

The SPEAKER. Under previous order of the House the gentleman from Massachusetts [Mr. Morse] is recognized for 30 minutes.

(Mr. Morse asked and was given permission to revise and extend his remarks and to include extraneous matter.)

Mr. MORSE. Mr. Speaker, today over 40 Members of the miniority of this House have introduced legislation which would create, if enacted by the Congress of the United States, a Commission on Public Management.

Mr. Speaker, among the Members who filed this legislation are the following:

F. Bradford Morse, of Massachusetts; John B. Anderson, of Illinois; Mark Andrews, of North Dakota; William H. Bates, of Massachusetts; Alphonzo Bell, of California; William S. Broomfield, of Michigan; Clarence Brown, Jr., of Ohio; Howard H. Callaway, of Georgia; Elford A. Cederberg, of Michigan; Don H. Clausen, of California; James C. Cleveland, of New Hampshire.

William C. Cramer, of Flomida; Glenn Cunningham, of Nebraska; Thomas B. Curtis, of Missiouri; Edward J. Derwinski, of Illinois; Robert Dole, of Kansas; John J. Duncan, of Tennessee; Florence P. Dwyer, of New Jersey; Robert F. Ellsworth, of Kansas; John Erlenborn, of Illinois; Paul Findley, of Illinois; Peter H. B. Frelinghuysen, of New Jersey; Seymour Halpern, of New York.

Frank J. Horton, of New York; Craig Hosmer, of California; Theodore Kupferman, of New York; Odin Langen, of Minnesota; Robert McClory, of Illinois; Joseph M. McDade, of Pennsylvania; Charles McC. Mathias, Jr., of Maryland; Chester L. Mize, of Kansas; Charles A. Mosher, of Ohio; Albert H. Quie, of Minnesota; Charlotte T. Reid, of Illinois.

Ogden R. Reid, of New York; Ed Reinecke, of California; Howard W. Robison, of New York; Donald Rumsfeld, of Illinois; Herman T. Schneebeli, of Pennsylvania; Richard S. Schweiker, of Pennsylvania; Garner E. Shriver, of Kansas; Henry P. Smith III, of New York; J. William Stanton, of Ohio; Bob Wilson, of California; and John W. Wydler, of New York.

Mr. Speaker, Congress has over the past decade enacted a host of creative programs designed to solve our public, social, and economic problems. We have made important strides forward in education, health care, pollution, control and urban development, but the dimensions of our remaining problems are staggering: 10,000 of our Nation's communities will face serious problems of air pollution; the demand for water consumption may exceed the available supply before the end of this century; there are 9 million substandard housing units in the United States, most of them in urban areas; traffic jams cost the Nation over $5 billion each year; and scientific and technical information is doubling every 15 years.

It is clear that problems of this magnitude are not susceptible to the traditional solutions. We must reach beyond our history for few ways to manage the public business effectively and economically.

We have available to us already a wealth of knowledge and technology in private industry. We have seen how new techniques of management analysis—the so-called "systems approach"—have streamlined our defense establishment and brought the universe within man's reach. We must now determine whether these techniques can help clean our water, educate our children and improve the quality of life in our cities.

We are today introducing legislation to establish a National Commission on Public Management.

This Commission would bring to bear on the management of public business the very best minds in private industry, Government, labor, and education. Its mandate is to answer two fundamental questions: How can new management technology aid us in solving problems that lie in the nondefense sector? What is the best way to take advantage of the opportunities these new techniques provide?

THE SIGNIFICANCE OF THE PROPOSAL

The technological revolution of our times has brought with it the capacity to solve the most difficult problems which modern society faces. And it has brought this challenge: Can our political creativity keep pace with the relentless march of science and with the mounting complexity of an increasingly urban society?

The Commission which we propose today represents merely the first step in an entirely new departure in American political thinking. We wish to see the free enterprise system with its new capacities engaged in and responsible for the solution of public problems. In one sense the concept is as revolutionary in political science as the technological explosion has been in physical science. In another sense, the concept is as old as free enterprise and America itself.

Systems management techniques and tools have given to the private sector a capacity for problem solving that the government has not yet developed. It is imperative to recognize the opportunity that this technology in private hands affords our society to solve gnawing and longterm social problems without relying solely on government to provide the answers, the machinery, the manpower and the money.

By engaging the private sector the government can employ the most modern technology available without expanding its own influence into the everyday lives of human beings.

We should not ignore the caution urged by those who see modern technology only as the precursor of a society of robots, where individual identity is subsumed in the mass production of everything from man's comforts to his personality. We can avoid that world, the world of "1984," only if we make the new technology our servant, and not allow it to be our master. The best assurance that the progress of science will not mean the insignificance of man is to recognize the revolution in technology, to anticipate its growth, to assure adequate personal safeguards from its excesses, and to employ it for the betterment of man. We must not merely be awed by science; we must be inspired by it to summon equal creativity in the political and economic fields.

Through basic systems management approaches, the increasingly serious and complex problems of water and air pollution can be brought under control. The new technology can test for pollution; it can anticipate pollution; it can provide the techniques to prevent and correct pollution. Using the systems approach society can measure today's needs against the supply for decades to come and can provide the formulas for conservation which can allow the citizens of today to take advantage of their resources without impairing the life of future generations.

The air and surface transportation problems of today are nothing compared to the problems which can be predicted for tomorrow. Systems management techniques can be applied to the problems of urban transportation to permit the free flow of city workers to suburban homes. And only the use of systems management techniques and equipment can resolve the incredibly complicated problems of air safety and air traffic simultaneously. Our systems are barely adequate today, and it takes no prophet to know that the growth of air travel will continue on its sudden expansion.

Increasingly, the problems of urban housing, urban renewal, and urban development will be appreciated, as they should be, as continuing concerns of an industrial society. The application of systems technology and of the equipment

upon which it depends can improve the efficient design of housing, can simplify the planning of housing patterns, provide for more efficient and rapid administration of housing development programs, develop testing systems to assure the maintenance of safe standards, and promise a life of greater ease and comfort in the home of every American.

In education, in health services, in law enforcement—and equally important in rehabilitation—in the distribution of public welfare—in all these areas and more, the United States has within its grasp a completely new set of tools. We must proceed carefully; we must proceed with order. But we must proceed. That is the reason why we propose this Commission—to survey the tools at hand and to consider their application to the problems which confront our society.

Three facts have led to this initiative. First, the domestic problems of our urban society are growing more awesome and complicated everyday, and too many assume that only government can solve them. Second, there exists a technology for problem solving and administration which seems uniquely suited for application to these public problems. Third, that systems management technology is in the hands of U.S. industry, which in a fortuitous alliance with Government can solve the problems within a framework of free enterprise. There is a need for political creativity now; and thus a need for the Commission we propose.

NEED FOR A NATIONAL COMMISSION

The tasks of management in both public and private enterprise have become more difficult and complex due to the very nature of the problems inherent in a dynamic and growing society such as ours and advances in science and technology. The problems of managing even the largest Federal programs of a generation ago were small compared to those of today. All levels of government—Federal, State, and local—are finding it increasingly difficult to solve their complex management problems on a piecemeal basis, to a large extent because they lack the management techniques and skills that have been applied so successfully in private industry.

Although there are studies in progress dealing with the use of systems analysis in several specific nondefense areas, the questions of where the systems approach is most applicable and how it best can be applied are still largely unanswered. It is our belief that these crucial questions require the attention of a Commission, appointed by the President and the Congress, to include the best minds in the field of modern management technology. This Commission can complete a comprehensive study and investigation, taking utmost advantage of the assistance of such testimony and consultation from recognized experts in the field as can be obtained during its active life of 30 months.

Some of our distinguished colleagues have recently introduced legislation which would authorize the expenditure of public funds, either directly by executive departments or through grants to the States, for contracts with universities or other public or private institutions or organizations which would attemp to apply the systems analysis approach to public problems. We fully support our colleagues on the basic issue of stimulating governmental support for such endeavors, but we also believe that a national commission is required first to provide the overall analysis and informed recommendations needed by all governmental authorities who may have reason to use the systems approach in the future.

Initially this Commission must define the problems involved. Then it must determine the applicability of the many systems analysis and management techniques as they relate to a myriad of problems ranging from those relatively simple and local in nature to extremely complex national issues. Finally, it must recommend optimum means for developing government-private enterprise cooperation to encourage and support the techniques found to be applicable. Unless these crucial points are investigated thoroughly, we will not be able to provide guidelines for the many future applications of the systems approach, and instead we will be limited to trial and error procedures. We require a "conceptual definition" phase—to borrow from Department of Defense terminology—before we can move full speed into the implementation phase. This, in fact, is merely using good systems analysis procedure.

Technology will continue to expand, and the Commission should anticipate its growth. The Commission should become a repository of information on how the management techniques presently available have been applied, provide information and guidance to business and government through seminars, confer-

ences, and appropriate publications and encourage the best talent in government, business, and the universities to study public management problems. It should consider how existing and new techniques can be fed into the legislative and administrative processes on a continuing basis. It should address itself to the question of how to insure that new legislative programs provide for data that will make systems management possible and take into account the necessary interrelationships between programs and agencies.

NEW MANAGEMENT TOOLS

What are these new management tools? Although there is no completely accepted name or definition covering the whole area of new management technology, it is generally referred to as the "systems approach". The concept has been developed primarily by the Department of Defense, the National Aeronautics and Space Administration and the aerospace industry for the development and production of major weapon and space systems. Although the term "system" is by no means a new one, the high degree of expertise in this area now available within a sizable segment of U.S. industry and the Federal defense and space agencies has only recently come of age.

The systems approach is a way of thinking about the job of management. It provides a means for arriving at the best solution to a complex problem or combination of problems by means of a logical process of identification and control of all their interrelated segments. The genius of the systems approach is its ability to bring order out of tremendous numbers of diverse and interacting elements and factors—order that not only stabilizes but creates the conditions for progress as well.

The approach has two main features. First, the problem or problems to be solved are rigorously defined, in terms of performance objectives rather than in terms of product specifications or particular technologies. Thus instead of specifying the types of garbage disposal, sewage, or antipollution devices required to provide an integrated waste management system in a community, the system objectives would be defined in terms such as the desired purity of the water supply, the percent allowable impurities in the air, and the convenience desired by the housewife in the disposal of solid waste—all tied to a realistic cost and time schedule.

The second feature of the systems approach is its emphasis on the interrelations within a system. Rather than dividing a problem into manageable subproblems and solving each independently, the systems approach enables the managers to develop and implement a plan capable of achieving the entire objective. It provides for comprehensive planning, traces out the effect of any set of choices and decisions upon all other relevant decisions, and then arrives at the solution to the total problem. Thus the problem of water resources for any given area involves water sources, land use, urban development, waste disposal, and recreational facilities. Since each factor is so closely linked with the others, the problem must be looked at as a whole.

Systems analysis has been described as "a technology which applies the scientific method to the allocation of limited resources among a variety of competing demands. The goals of the system are defined—the train must arrive on time; the constraints and conditions are stated—cost or time limits. Systems analysis attempts to arrive at the optimum satisfaction of the goals within the stated condition."

The application of the systems approach and its related analytical tools to the solution of a large variety of national and local problems in the nondefense sector holds great promise for the future. The possibilities have already been recognized by a number of commentators.

The National Commission on Technology, Automation, and Economic Progress, in its February 1966 report, pointed out that:

"There is a strong need for the development of systems analysis capabilities in individual branches of the Government and in Congress. Beyond this, there is the broader question of how these different intellectual resources, which are being employed primarily to deal with the programs of the agencis, can be coordinated and used for the analysis of the various social problems that confront us."

In addition to specific recommendations for the application of new technologies and management techniques in such areas as health care, transportation, control of air and water pollution, and housing, the Commission pointed out the need to improve the decision-making process which determines the priority of various proposals. The Commission said:

"Such decisions are often made piecemeal with no relation to each other—vested interests are often able to obtain unjust shares, and—few mechanisms are available which allow us to see the range of alternatives and thus enable us to choose with a comprehension of the consequences of our choices."

CURRENT EXAMPLES

Examples of attempts to apply these modern management principles to State and local affairs already exist.

The so-called "California studies" make up one such set of examples. In November 1964, the State of California announced its plan for the application of systems engineering techniques to four important public problems.

This plan was predicated on three primary considerations. First, national consideration was being given to the possibility of reduced Federal spending in defense. Second, California had a particularly large investment in the defense, aerospace, and electronic industries, and was therefore particularly vulnerable to a cutback. These industries also provided the State with experienced practitioners in systems technology. Third, the State had a continuing concern with a number of problems: air and water pollution, crime, population growth and planning, welfare, education, and so on.

Preliminary discussions between the Governor's office and industry leaders indicated that there was considerable enthusiasm for initiating studies to determine the feasibility of applying "systems engineering" and "systems analysis" to socioeconomic problems. As the likelihood of reduced defense spending diminished, the focus of these discussions changed somewhat from "How can we help the distressed aerospace industry?" to "How can we make a new and broader use of available skills?"

Following a round of competitive bidding in which each bidder outlined the approach he would take and the resources he would apply to the study, the State of Californa awarded four $100,000 study contracts to aerospace firms. The areas selected for study were transportaton, waste management, crime, and information control.

The State of California is currently evaluating, with the assistance of the Ford Foundation and others, the results of these four studies. Preliminary evaluation indicates that it is feasible to apply the systems capability of the aerospace industry to socio-economic problems and produce meaningful and valuable results. In fact, California is so enthusiastic over their success that additional studies are being initiated to utilize the systems approach in analyzing land use in Santa Clara County and statewide social welfare programs. The State antcipates conducting follow-on studies on a solid waste subsystem of an integrated waste management system, a statewide crime information system, and a federated statewide information system tieing together all State and local agencies.

One can cite many other examples of systems analysis applied by forward-thinking governments. The city of New York, under the dynamic leadership of John Lindsay, is moving toward a near real-time information system which will tie all of the city's departments and agencies into an integrated computer-based system. This system will provide data in usable form for the policymakers as well as for those at the operating level.

New York State is currently developing a computer-based identification and intelligence system for law enforcement, the first of its kind in the world. The system will provide unified information to all State and local agencies which deal with the administration of criminal justice. The agencies will have access only to that portion of the information which falls within their respective legal, right-to-know restrictions. The scope of the system is broad:

"In support of the normal daily operation of (state and local) participating agencies, the fully implemented system will provide rapid access to summary criminal history, as well as detailed criminal, social, and modus operandi data on each subject; will rapidly transmit graphic data, such as photographs and fingerprints, fraudulent checks, warrant-and-wanted notices, stolen motor vehicles, stolen property, laundry marks, stocks and auto registration forgeries; and will provide direct scanning and computer-based searching of all fingerprints on file, the arrest and disposition reports, and intellgence information."

Even in the international field the systems approach is finding adherents. The Greek Government announced last March that it is negotiatng a multimil-

lion dollar contract with a large diversified American industrial concern for regional economic development on the island of Crete and western Peloponnesus. The U.S. firm, applying the system approach and developing proposals for review and approval by the Greek Government, will provide the management capability. In 10 years it s hoped that both regions will be industrialized and transformed into tourist attractions.

These illustrations only scratch the surface of the many large system projects we can anticipate. We can reasonably predict that many other public problems, as yet unheard of, will demand solution. As Mr. Karl G. Harr, Jr., president of the Aerospace Industries Association, has stated, "only if this stuation is fully grasped, only if the experience in coping with such problems which are already at hand is analyzed and applied, and only if the total potential for addressing these problems is positively exploited, will future managers both in government and out have the tools with which to marry technological advances with a society of free men and free institutions."

We need to focus attention on these challenging ideas at the highest levels of government. The examples cited indicate that the systems approach can be used. However, we need to take a longer, more comprehensive, look at the total opportunty for applyng the resources we have available to us. The proposed Commission can provide this necessary perspective.

THE JOB OF THE COMMISSION

What specific types of questions could such a Commission be expected to study and investigate?

One question would involve the definition and categorization of those social and economic problems in the nondefense sector to whch the application of the systems approach appears to hold promise. Some of these are obvious, particularly at the national level, but others such as local community problems are more obscure and require thoughtful analysis.

The California studies provide a representative listing of the most crucial of the current problems facing a large State. But other States and local communities will have different needs which can also be approached from a total systems standpoint. At the national level, the problems of relating sometimes conflicting State and local problems into an integrated regional or national system require a thorough analysis.

The distinctions between the use of systems techniques for planning, organizing, and controlling public programs also deserve considerable attention by the Commission. Planning procedures and tools such as the Planning, Programing and Budgeting System (PPBS), cost-benefit analysis, mathematical modeling and simulation, operations analysis, and others need to be studied in the context of the real life environment of Federal, State, and local government planning operations to determine how they can best be utilized.

The planning, programing, and budgeting system—PPBS—is an adaptation of a management tool originally used by the Department of Defense to develop a clearer relationship between the planning operations of the various defense sectors and the annual budgeting operations of the Department. PPBS is currently being installed throughout the executive branch of the Federal Government and is also being studied by several State and city governments. It seems certain that the general principles of PPBS will be applicable and perhaps mandatory for most future public programs.

Cost-benefit analysis, or cost-effectiveness evaluation, is another management planning tool developed by the Department of Defense. It provides a framework of analysis enabling us to select between competing programs based on the benefits versus the cost of several alternative approaches. In the defense area, benefits or effectiveness can be defined in terms of kill probability or payload or other such quantitative measures. In the nondefense sector, the definition of effectiveness becomes extremely complicated by human factors and political consideration.

The use of mathematical modeling and simulation is widely used in management training programs to illustrate the effects of specific decisions in particular business situations. Many other variations of modeling are in use, all with the objective of eliminating the need for costly trial and error in the real world. But they all have certain limitations which need to be analyzed in conjunction with their proposed application.

These planning tools can be effective in streamlining the decision-making processes involved in any type of public program. The decisions, of course, remain the responsibility of the authorized officials, but the facts required to arrive at these decisions can be made more readily available and useful.

Other types of management techniques developed recently are concerned with the control of complex programs during their implementation. These management tools are identified by such acronyms as PERT, PERT/Cost, PAR, and many others. Basically they can be described as near real-time computer-based information systems, such as those being developed in New York State, which provide the feedback information on program activities that is necessary to quickly isolate problem areas for prompt management action. These techniques have been proven in some of our largest weapon system developments such as the Polaris and Minuteman ballistic missile systems. They now need to be studied as they relate to public programs in the nondefense area, where success involves a large human and social element rather than the hardware-oriented output of the defense and space fields.

THE ROLE OF GOVERNMENT

Overriding all of this is the question of an optimum organization—both at the public and private level—to accomplish effective system planning and implementation. This question of organization leads logically to a Commission review of the appropriate relationships between and among several overlapping systems and the demands thus placed on intergovernmental coordination at the Federal, State, and local levels.

Should there be a program manager responsible for all activities in a given problem area and organizationally located in one level of the several State and local jurisdictions which may be involved? Or should the responsibilities be divided among several jurisdictional authorities? In either case, should an industrial prime systems contractor be hired on a turnkey basis? Or should the systems management responsibility reside within the Government, with major pieces of the job given to several associate contractors? These and many other questions need studying to determine the best of the multitude of systems management techniques for use in any given situation.

The geographic boundaries and historic charters that once created obvious administrative divisions are no longer of central importance. For example, the problem of pollution in the Merrimac River is one involving at least two States and several local communities. They must find new means for working together to solve this problem, irrespective of jurisdictional lines.

Functional interests have already been the foundation for hundreds of new governmental units: agencies and boards to run airports and ports, to administer reservoirs, to build highways and to educate children. The resident of Boston is governed not only by the city government, but by the Massachusetts Port Authority, the Metropolitan District Commission, the Massachusetts Bay Transportation Authority, and a plethora of other boards and commissions. An awareness of these revolutions in jurisdictional authority must be included in any thorough analysis of government's partnership in public programs.

We are all aware of the problems which can arise when two programs or two levels of government, in pursuit of separate but somewhat overlapping objectives, proceed with tunnel vision toward their respective goals. This situation arises on the national level as well as on the local leve. The need for intersystem management to coordinate such efforts is apparent, but the optimum methods for accomplishing it need to be determined.

One source which can be tapped to assist in this endeavor is the wealth of experience in the systems approach residing within those Federal research and development agencies involved in the Nation's defense and space effort. There is a need to determine how the other Federal administrative agencies and State and local governments can best expose their own personnel to this experience by cross-training programs with the Department of Defense and the National Aeronautics and Space Administration. There are attempts now being made to accomplish some of this interagency transfer of systems experience. For example, the Institute for Defense Analysis and the Department of Defense have developed the defense systems analysis education program. Officer and civilian personnel from the Department of Defense, the Department of State, and the CIA are receiving training by IDA and University of Maryland personnel in an effort to fill the need for decisionmarkers skilled in systems management tech-

niques. The stimulus of a national commission investigating the opportunities and procedures for transfer would be most welcome in encouraging and advancing this trend for nondefense agencies.

GOVERNMENT-INDUSTRY RELATIONSHIPS

Another area for Commission study would most certainly involve an appraisal of the proper relationships between the various levels of government and the private sector. The question of the proper balance between public and private investment must receive careful analysis. The level of governmental activity will vary with each class of problems and it is doubtful that the approach that satisfies one class will be useful in another. The Commission would be expected to recommend the best means for stimulating private investment wherever possible. Conversely, where direct Government investment is necessary, the Commission would provide suggested guidelines for the proper balance between Federal and local funds.

As we proceed past the initial phases in the application of the systems approach to public problems, it will become more important to use the best possible techniques for supporting private industry. The possibilities include several types of modern contracting methods, such as incentives and award fees; and various other financial transactions to stimulate private effort, such as loans, tax incentives, and cost allowances. Also needed is an analysis of which level of government is best qualified to handle the end funding and with what control from other authorities. It is likely that different procedures will be suited to different situations. It is quite possible that the Commission's efforts can lead to better methods than have yet been devised for solving the procurement problem.

INDUSTRIAL SYSTEMS CAPABILITY

Along with study of the applicability of the systems approach and the Government relationship to systems, management, the Commission can investigate the requirements which will be placed on private industry—both in aerospace and nonaerospace companies. It is highly probable that even those aerospace companies with the most experience with the systems approach will find that the application of this approach to new kinds of public problems is different from their past experience. The California studies have shown that the systems approach is feasible, but that its application requires a certain amount of experimentation to determine the best way to proceed. In other words, the systems approach cannot be transferred directly from the aerospace environment to socioeconomic concerns without some modification and a learning process by all those involved.

In fact, the review of these studies by the California Department of Finance points out many problems which require further study. Systems analysts from the aerospace industry are used to working for large, rich, monolithic organizations. State or local agencies, and even the Federal agencies concerned with socioeconomic problems, must operate with limited budgets which cannot readily be expanded beyond estimates. Changes in legal authority and in budgets and procurement regulations may be required.

In the aerospace context, the value of a system is usually well defined in terms of capability versus dollars. But in government these values may be less clear. The value of murder prevention or a 50-percent reduction in air pollution is difficult to define quantitatively.

The California evaluations also noted weaknesses in certain broad areas common to each study. There was a feeling that conclusions were perhaps too positive for the brief nature of the studies and the size of the problems. There was a feeling that some of the ideas presented were imaginative and appealing and very probably workable, but not totally and adequately proven. In some cases, the cost factors for implementing the presented recommendations were considered inadequate. There was concern that many of the legal and political problems in implementing the recommendations had been slighted. It was found that the establishment of criteria for the evaluation of any activity was extremely difficult and frequently highly arbitrary. Similarly, the analysis of methods of evaluation against these criteria was often inadequate. A potentially serious problem is that of communication between the systems oriented scientists and the specialists in the substantive areas. It was found that

scientists and engineers whose background is in military culture and hard sciences often find it difficult to communicate with those steeped in social, economic, political, and behavioral sciences.

These points are mentioned not to degrade in any way the notable success of the California studies and the excellent jobs done by the aerospace companies involved. They do emphasize, however, the need to iron out some of the natural problems of transition from one frame of reference to another.

ROLE OF SMALL BUSINESS

An important area for investigation is the role of small business in the solution of public problems. It is clear that the industrial teams required for implementation of these socioeconomic systems will not be made up entirely from big industry. The unique talents of small business will be required as much here as they have been in the development and deployment of weapon and space systems. Yet to be determined, however, are the specific contributions which small business can make, and even more importantly, how they can best be brought into the scheme of things.

An excellent example of one of the approaches which has already been taken in this area is a recent executive seminar entitled "The Management of Growth and Technological Change," conducted by Northeastern University and Harbridge House and sponsored jointly by the Small Business Administration, the Department of Defense, and the U.S. Arms Control and Disarmament Agency. This seminar provided a forum for 30 corporate executives, representing small technically based firms in the Boston area, to explore, by means of case studies, the experiences of firms which had responded successfully to drastic changes in their product markets. The seminar also highlighted the management techniques involved in analyzing corporate capabilities, market prospects, and the development and execution of a strategic plan for growth. Even more importantly, it served to stimulate the collection and analysis of data by the participating firms and the development of a plan for individual company growth. The program was so successful that Northeastern University is now undertaking additional case studies for use in future seminars.

The Commission could undertake an expansion of this seminar concept in cooperation with universities throughout the country. Its findings can provide an important service to the small business segment of our economy as it strives to keep pace with rapidly moving technology.

In addition, these findings can be expected to speed the adoption of modern systems analysis and management techniques by smaller companies in nonaerospace industries, so that they too will be capable of attacking public problems using the systems approach. We would expect the final Commission report to be a highly educational monograph which can be used by these companies and, in the field.

LABOR PARTICIPATION

We consider it most important that organized labor play a significant role in the activities of the Commission. There will be many questions to answer concerning the requirement for retraining and relocation of the labor force in response to the application of new technology and modern management in public programs. Other groups, such as the National Commission on Technology, Automation, and Economic Progress, have studied this area, but more effort is required. We must insure that the high productivity and capability of this Nation's labor force is utilized as efficiently as possible in any of our planning for the future. For in the end, no matter how good our scientific and management tools may be, it is the worker who digs the holes, lays the bricks, and connects the wires which give any project its final form.

USING UNIVERSITY RESOURCES

The university community can also participate in and contribute to this endeavor in several important ways. A number of colleges and universities are already offering courses and degree programs in operations research, and business and engineering administration programs reflect the emphasis on new management techniques. The number of data processing complexes in the universities has nearly doubled in the past 3 years. In fact, the requests of the 36 colleges and universities seeking assistance under the National Science

Foundation computing facilities program totaled $14,664,316 for fiscal year 1966. The effectiveness of these programs should certainly be a subject for careful study by the Commission.

In addition, there is an obligation to utilize the intellectual resources of the university in both an objective determination of the problems suitable for investigation and in the applicability of the various management techniques to these problems. This will provide the universities with an important opportunity to gain intimate knowledge of the real problems confronting the managers of public programs. This knowledge will enable the universities to prepare future generations of managers through revision of current curricula and addition of new courses. One educator has called for the development of "highly qualified generalists—men able to correlate knowledge in different fields in a meaningful and predictable way. Furthermore, there is a logical argument that engineering is now taught backwards," producing specialists in various technical disciplines instead of graduates with "broad systems understanding" which puts business, engineering, economic, social, and other problems in perspective.

To counteract this tendency, the Commission could study the feasibility of Government cooperation in establishing or encouraging the formation of interdisciplinary groups within the university which would combine the study of all aspects of current and future public sector problems.

COMMISSION OPERATION

With these and many more questions and issues to study and investigate, the Commission should have a busy and fruitful existence. The Commission would conduct a full schedule of hearings, receiving testimony from the recognized experts in the systems field representing all segments of our society. It could draw on the advice of consultants as required, and could contract directly with private organizations to conduct more detailed studies of certain specific subjects, if this were deemed necessary. In addition, it would be appropriate for the Commission to sponsor one or more seminars in order to stimulate informal discussion and help to generate additional support from both public and private leaders. The seminars could be held on a geographic or functional basis.

At the end of the first year, or definition phase, the Commission will have completed its preliminary analysis of the subject and prepared an interim report for submission to the President and Congress. This report will include a precise description of the problems to which the Commission is addressing itself, a preliminary analysis of the applicability of various systems analysis and management techniques to these problems, and a detailed plan for a continuing study leading up to the final report to be submitted 18 months later.

This final report will contain explicit plans, including completed case examples, for applying particular systems analysis and management procedures to specific public problems. These plans would contain estimates of cost, staffing requirements, schedule, skills required, and other hard data for each application, so that any government agency at the Federal, State, or local level would have ready access to usable guidelines. In addition, the Commission's final report would be expected to contain recommendations for legislation, Federal executive action, and State and local governmental action in order to better facilitate the application of modern technology and systems analysis to the solution of current and future public problems.

We have attempted to describe some of the benefits and accomplishments which can be foreseen from the initiation of an effort at the national level to analyze in depth the application of these systems techniques to our many national and community problems. We are sure that none of us can forecast the full measure of worth to this Nation which such an endeavor may ultimately provide. We are equally certain that the use of modern technology coupled with the application of modern management techniques may provide solutions to many of the problems which now appear insoluble. It is up to us in the Congress to insure that these steps are taken in a timely fashion.

[From the Congressional Record, Jan. 10, 1967]

NATIONAL COMMISSION ON PUBLIC MANAGEMENT

Mr. MORSE of Massachusetts. Mr. Speaker, last August more than 40 Republican Members of the House introduced legislation to create a National Commission on Public Management with the mandate of determining whether the

management techniques of systems analysis, developed so successfully in our space and defense programs, could be applied to the solution of nondefense public problems such as transportation, pollution control, health services, and others. Since that time we have received considerable expressions of interest and support for the legislation and for the concept of using our most modern management tools to improve the quality of American life.

On November 4 the board of directors of the U.S. Chamber of Commerce gave its endorsement to the measure and we have been most heartened by the expressions of interest from the business community.

There is also increasing evidence at all levels of government that the old approaches are no longer sufficient. In our initial statement we commented at length on the California research contracts, and we have also been made aware of the efforts in New York State, New York City, and other areas to use these new tools to improve governmental efficiency and effectiveness. Vice President Humphrey, speaking on November 16, said:

"We have seen, too, what government research and development contracts given to the university and to private corporations have produced in overcoming scientific and technological obstacles in the remarkably short time.

"The same partnership concept, the same systems approach; the same investment in research and development, applied to other public needs may prove to be the way in which our rich nation may finally be able to overcome economic and social problems which have been generations in the making."

Senator NELSON of Wisconsin has also introduced legislation that would approach the application of modern management to the public sector. In short, Mr. Speaker, there is growing agreement that rational management will be required if we are to allocate our resources wisely and develop comprehensive approaches to our mammoth public problems. Right here in the Congress we made a start in this direction last year in passing the Demonstration Cities and Clean Rivers Restoration Acts, each designed to encourage a comprehensive program to revitalize our cities and clean up our rivers and streams.

I am very hopeful that we can focus attention on these new tools at our disposal in the 90th Congress and am reintroducing the bill along with 40 of my colleagues. Early hearings on the measure would help to educate the Congress and the public on the possibilities for a completely new attack on our national problems, on the dimensions for participation that these tools open up for the private sector, and on the experience of States and cities in applying these techniques.

Mr. MORSE. I would also like to submit for the record and call to your attention, Mr. Chairman, an editorial which appeared in the Washington Star on January 16 endorsing the approach which I have discussed.

Senator NELSON. That will be printed in the record also.

(The editorial referred to follows:)

[From the Washington (D.C.) Evening Star, Jan. 16, 1967]

WANTED: SPACE-AGE GOVERNMENT

Amid the uproar as the 90th Congress opened for business was a little-noticed bill introduced by Representative F. Bradford Morse of Massachusetts. We will hear of this measure again. For it not only has the backing of 40 other Representatives and 10 Senators, but it proposes a remarkable idea: Applying private management techniques of the space age to our creaking government machinery.

The bill would create a National Commission on Public Management. Members, appointed by the President, would study and recommend ways in which sophisticated tools of industry, such as computers and systems analysis, would be used to solve public problems.

There already is precedent for such action at the state level. New York State, for example, is developing a computer-based intelligence system for law enforcement. California, aided by the Ford Foundation, has farmed out contracts to aerospace firms to study how the state can best solve problems in transportation, waste disposal, crime and information control.

The point of all this is that while the problems of urban life have been mounting and increasingly thrust upon the federal government, the techniques of

dealing with them have not. Welfare, for example, is a maze of federal, state and local jurisdictions. Flood control is supposedly the domain of the Corps of Engineers, yet what happens 200 miles upstream in forest cutting and planting has a direct effect on floods—and comes under the purview of other government agencies.

Mr. Morse and his colleagues are to be commended for stepping back and viewing the problem in a new perspective. Congress should open hearings soon on this broad-gauge proposal. The richest, most powerful nation in the world should make sure it is availing itself of the best management tools available.

Mr. MORSE. With respect to the difference between the two bills, there are minor differences between the bill originally introduced in August in the House and in the Senate, and the bill which has been introduced this year by Members of the U.S. Senate.

Section 1 of the bill which has been introduced by Senators Scott, Dominick, and others in the 90th Congress makes specific reference to unemployment and education in section 1.

In section 2 of the bill, which deals with the membership of the Commission, the Commission would be composed of a Chairman, a Vice Chairman, and 11 other members. In the original bill and in the present House bill, section 2 specifically requires congressional Members, two Members appointed by the President of the Senate and two Members by the Speaker of the House of Representatives.

The bill which has been introduced by Senator Dominick, Senator Scott, and others in the Senate this year does not have the requirement for congressional Members. I would like to point out that in the event your committee does conclude that some combination of the Nelson approach and the approach we have offered previously is feasible and the Commission might be in order, I would urge that congressional Members be included in whatever recommendation the committee makes.

Section 5 of the present Scott-Dominick bill differs from the original bill in the compensation for members of the Commission, which was originally $100 a day. According to the current Senate bill, it is $75 a day.

Section 8, subsection (a)(6) of the bill identifies specific problems and includes in the new version unemployment, public welfare, education, and other specific problem areas. The new Senate bill in section 7 provides for the authorization of a half million dollars maximum for the first year. The House bill provides for an authorization of only $200,000. I think the Senate figure is far more realistic.

I do not see any basic inconsistency between the National Commission approach which I have recommended and the Scientific Manpower Utilization Act which the chairman has proposed. I think clearly the goals are the same, but I would warn against confining ourselves to a grant-in-aid approach at this time.

Senator NELSON. I didn't hear what you said.

Mr. MORSE. I think the two bills are compatible. There isn't any basic inconsistency. But I do have some doubt as to whether we should confine ourselves to a grant-in-aid approach, which seems to be the principal purpose of S. 430.

Since the initial introduction of the Commission bill, which is H.R. 20, a number of projects already underway by States and others have been brought to my attention. We are all familiar with the California projects, which involved State contracts. I am also aware

of other studies which have been initiated by private industry and then brought to the attention of Government agencies, of consortia of systems and nonsystems firms combining to develop a systems approach to a specific problem, and of systems models developed for one area, but with application for others.

In short, I think there is so much activity already underway in this field that we should take a comprehensive look at the "state of the art" and try to develop a coordinated approach to our mutual goal; in other words, take the "systems approach."

There is a danger that we will fragment our efforts in this field, just as we are now fragmenting our efforts in transportation, pollution control, and the other areas where we seek change. The California experiment worked particularly well in that State because of the presence of the leading aerospace firms with the system capability and the academic base for university-industry cooperation. I am not sure that this model would be as applicable in other States.

What I would suggest, Mr. Chairman, is a combination of our two approaches. I see no reason why a National Commission on Public Management with a broad mandate could not serve as the administering agency for the types of contracts you contemplate in the Scientific Manpower Utilization Act, while at the same time exploring other possible financial approaches and making a complete study of the techniques for the solution of the problems which plague us.

I do not suggest that the Commission bill does not lend itself to amendment. I would be interested in suggestions as to how to insure that rapidly advancing technology would be available to Government on a continuing basis. Rapid obsolescence is one of the principal problems we face. I would be interested in comments on the estimated cost of the Commission's efforts in terms of its very broad mandate. And I would welcome comments on any of the specific duties of the Commission as listed in section 3(a) of H.R. 20.

There is really much more at stake here than any individual piece of legislation. We are on the threshold of an entirely new approach to the management of the public business. Last year an esteemed political scientist told me that the concepts which were included in the bill which I filed and the bill which the chairman of this distinguished subcommittee filed were as much of a dramatic departure in the field of political science as the discovery of the atom bomb was in the physical sciences.

The hearings which you are holding this week are part of an important educational process both for the Congress and for the public. The implications of our mutual exploration are great: for intergovernmental relations, for the structure of Federal, State, and local governmental units, and for the relationship between business and government.

I think we can go forward with specific projects as contemplated in S. 430, but I think we must also make the broad inquiry that is suggested by H.R. 20.

Thank you very much, Mr. Chairman.

Senator NELSON. Have you had the opportunity to check on what source of personnel there might be for heading up any kind of program in the systems analysis field; that is, where are they being trained, apart from the aerospace industry, for example?

Would it be part of your idea that the National Commission would explore the question of where you will get the personnel to be utilized by the States and the Federal Government to be used in this program of systems analysis?

Mr. MORSE. The trick would be finding the people to do the job, Mr. Chairman. There is a great abundance of competence in the private sector. I am pleased to note that in recent months a number of governmental agencies have obtained the services of the people who have been trained in the systems disciplines.

For example, Dr. William Whitson has recently been retained on a consulting basis by the Agency for International Development to inquire into the feasibility of the application of systems techniques to our foreign aid program.

The Department of State has a small office within it which is seeking to determine the application of systems management techniques on some of our diplomatic problems.

One of the great difficulties both agencies have had has been in finding qualified people who can participate in the type of activities in which they are engaged. I am sure that the Commission which I envisage would be charged implicitly with the respnsibility of determining the availability of skilled and trained systems people for this kind of public application.

Senator NELSON. You don't think there is any question about the idea of using a commission approach to make some kind of a study and evaluation of the status of the art and the need for the application of this concept. I certainly endorse that concept. However, is it not true that there do exist the specific problems right now in which we can apply the concept; for example, air pollution and water pollution?

The big problem has been that we have tackled this issue of pollution piecemeal and in fragments in various parts of the country. The facts is it has to be tackled on a natonwide basis. Air and water travel across State lines. What happens in New York to Lake Erie affects all States bordering that lake. What happens to Lake Michigan on the southern tip, so far as pollution is conerned, affects Green Bay in northeast Wisconsin, and the whole coast of Michigan.

Senator DOMINICK. Did you hear what happened in Boston yesterday? They had an excess of air pollution. They found it was because the wind was coming from the southeast. The air pollution collector was heading northwest and it was getting all the smoke from the Health and Welfare Building and that is what was creating the air pollution.

Senator NELSON. I think that emphasizes the fact that the problem has to be looked at in toto and evaluated on a nationwide basis.

Mr. MORSE. Yes. I think it is appropriate that Federal agencies, wherever they deem the application of systems techniques to be feasible, should be encouraged to go on.

The Department of Commerce at the present time has let a systems analysis contract rather than a systems management contract, with reference to the high-speed rail transportation in the northeast corridor. I think this is a perfectly proper application.

It does seem to me, and I plead my own ignorance and lack of full understanding of the systems techniques, that it is desirable

that we get the best minds in our society to make a broad gage study as to just how the techniques should be applied rather than once again doing it piecemeal.

I am apprehensive about doing things on an ad hoc basis where it seems to me we should first make a comprehensive study of the areas of feasibility. There may be some areas which quite obviously would lend themselves to the application of systems techniques. The chairman has mentioned waste management and pollution control. Transportation is another.

There are perhaps many other areas in which systems techniques would immediately lend themselves or would lend themselves after study.

Our postal system certainly is something that ought to be thought of, perhaps, in systems terms. There are some of the problems of education that certainly would, with the proper understanding, be subject to improvement by the application of systems techniques.

I think we have to get the best minds in our country to think about this in an organized way before we can really hope to gain the full advantage from the techniques which our private sector, especially our aerospace and electronics industries, have developed.

As I said, Mr. Chairman, I don't see anything inconsistent about this sort of study that I suggest and the solution of specific problems which are suggested by the chairman's bill. I do have some doubts as to the grant-in-aid approach. It is not that I argue against it; I don't. But as the chairman just noted, many of the problems that we have are national problems.

The matter of pollution is a national problem. The water that goes in the Merrimac River from New Hampshire to Massachusetts doesn't purify itself when it passes the State line.

I am not sure that limiting ourselves to grants-in-aid to the States is the proper approach. I think we confine ourselves unnecessarily when we do that. But I would certainly urge that you and your committee carefully consider the combination of the two approaches: the creation of the Commission and the inclusion among the Commission's responsibilities of serving as the agency which would make the awards which are contemplated in S. 430.

Senator NELSON. The bill that I introduced does contemplate grants to individual States and to groups of States where the problem is regional.

Mr. MORSE. Yes, and I applaud that, Mr. Chairman.

Senator NELSON. I think we all recognize that the so-called concept of systems analysis, itself, is very old; that the only thing that is new is that we are now able to use computers in order to implement the systems engineering concept.

It seems to me that one of the things we are going to have to do is to encourage the States, for example, to develop their own comprehensive State plan. One of the necessary tools in applying the concept of systems analysis, itself, to any problem is that we have the basic facts. Wisconsin is one of the few States to develop a comprehensive State plan.

We used the systems analysis concept, although we made very little use of the computers. It is necessary, it seems to me, for each State

itself to have a comprehensive State plan in order to really utilize the concept.

You need to know, No. 1, where your population was 30 years ago and where it is now, so that you can project where it is going to be 20, 30, and 40 years from now. We did a population analysis and a population projection. Then we used overlay maps so that we could take any area of the State and drop an overlay map down for 1980 and then see where the cities will be, where the people will be, and another overlay to see where it would be in 1990, and another one for the year 2000.

For example, once you have the basic population figures and a good, sound projection of where your population and traffic is going to be 20 or 30 years hence, you are in a position to start a transportation study now, recognizing where the traffic is going to be and recognizing that you ought to do some preemptive zoning in order to preserve areas for your traffic in the future. If we had done this in the past it wouldn't be necessary to condemn valuable property to create traffic arteries.

You proceed from there to an analysis of your public facilities. When you look at population, you also have to have a qualitative analysis of the population so that you know how many kids will be 5 and 6 years old and entering school 20 years from now; how many are going to be of college age 20 years from now; how many are going to be elderly; what percentage of the population will be elderly and retired 20 years from now; what percent of the population will be mentally retarded, so we can project our institutions for the mentally retarded, our institutions for the elderly, our institutions of primary and secondary learning, and college.

Once you have your basic population figures and a qualitative analysis of them, then you can proceed from there with a comprehensive public facilities projected plan, a transportation plan, a recreation plan, each of them using various techniques, including overlay maps to designate to the people who have to do the planning and the legislators who have to do the legislating as to what the problems are going to be 10, 20, and 30 years from now.

The only thing new in the whole business is that we now have computers so that we can ask a question and get an answer in a matter of minutes.

A lot of people make the mistake of thinking that systems analysis is the use of computers. Computers are simply a tool to be used in systems analysis. The first people in the business of using computers in systems engineering apparently were the aerospace industry and then, of course, over in the Defense Department.

Senator Dominick is a member of the Labor and Public Welfare Committee and a cosponsor of the bill on our side. We intend to work together to develop a bipartisan bill that will be acceptable to the Congress.

Senator DOMINICK. Mr. Chairman, I am delighted to be at these hearings. I want to congratulate Congressman Morse for having initiated the work in the House on this particular type of proposal. I want to say I am going to look forward to these hearings with interest. Unfortunately, after you had set your hearings, the Armed

Services Committee scheduled an executive session on the supplemental defense bill for Vietnam. Since I have been appointed to that committee, I will have to go there.

I want to welcome the valuable aid and assistance that Mr. Morse has given to this very important problem.

I want to say to you, Mr. Chairman, that I hope we can work this out in a fashion which will enable us to move forward in this session. I think it is of extreme importance.

It does seem to me that the major difference at the moment between the approach that you suggest in your bill, S. 430, and the one that we suggest in S. 467 is that you have more or less solidified on the system of grants to the States. We are asking that a commission be appointed to determine whether this is the best way to approach the problem.

There is a pretty strong difference here, but I think perhaps we could work out a compromise. It does seem to me that there are certain problems which could be worked out by the States, such as the system that you mentioned you started in Wisconsin, but I would suspect there are a great many States in our country who are wholly, we will say, at sea as far as putting this type of operation into effect.

It would strike me that perhaps what we ought to do is to go fairly slowly to see if there might not be somewhere along the line a regional approach which would be more fruitful than the State approach. I am thinking of the Rocky Mountain area where I come from. The pollution problem in that area is growing. There isn't any doubt that the growth of population in that area will be fantastic over the next 20 or 30 years. Perhaps a regional approach to these problems would be more effective than the other. I don't know. I am not expressing any necessary predilection that way. It does seem to me that a Commission study of this might be fruitful.

Once again I want to welcome Congressman Morse for his initiative and able leadership in this field.

I apologize to you, Mr. Chairman, for having to leave, although I see I have my very capable senior colleague, Mr. Javits, to take care of our side of the aisle.

Senator NELSON. Thank you, Senator Dominick.

Senator Javits is a member of the Special Subcommittee on the Utilization of Manpower and participated in the hearings last year.

Senator, you did not have the opportunity to hear Congressman Morse's testimony, but if you have some questions you would like to address to him, the floor is yours.

Senator JAVITS. I express my pleasure in having him testify as one of our most gifted Members of the House, and to state for the record that his bill has been introduced here in the Senate by Senator Scott, of Pennsylvania, with me as a cosponsor.

Mr. MORSE. Thank you, Mr. Chairman.

Senator NELSON. Thank you very much, Congressman Morse. We appreciate having you come. Even I recognize you as a very creative and brilliant Congressman.

Mr. MORSE. Thank you, Mr. Chairman.

Senator NELSON. Our next witness is Karl Harr, Jr., president of the Aerospace Industries Association of America.

STATEMENT OF KARL G. HARR, JR., PRESIDENT, AEROSPACE INDUSTRIES ASSOCIATION, ACCOMPANIED BY WARD DENNIS, NORTHRUP CORP.; AND H. L. WHEELER, NORTH AMERICAN AVIATION

Mr. HARR. Mr. Chairman and Senator Javits, the Aerospace Industries Association represents the principal manufacturers of aircraft, missiles, and spacecraft and their components—in short, the aerospace industry. This industry manufactures virtually all of the Nation's commercial and private aircraft, helicopters, and the like, but it is still, despite the tremendous growth in commercial air transport and general aviation, primarily a supplier of weapons and space systems to the Federal Government.

As such, it has been a principal partner in the evolution of a body of highly developed capabilities for the solution of complex problems which are frequently referred to as the systems approach.

My remarks will be directed at the feasibility of applying this approach beyond the national defense and space effort, particularly to problems connected with improving the quality of American life.

Many of these problems, such as air pollution and water pollution control, relief of traffic congestion, provision of adequate food supply, school systems, housing, and crime control are already fully identified and very much on the front burner of public concern.

The question is: How much, if any, of the systems approach techniques and capabilities developed in the course of our national defense and space efforts can be effectively transferred to the solution of those other problems?

Certainly the answer requires at least understanding how the systems approach came about, what it is, the scope of its potential application, and what is needed to effect that application. And perhaps first a word of caution.

One of the greatest values of the systems approach lies in the enormous number of variables it can encompass. But there is danger of being complex for complexity's sake, and that particular danger is nowhere more manifest than in the dialog surrounding this subject.

Most of the important considerations involving the systems approach are, to the contrary, quite simple. Such is certainly the case with respect to the genesis.

All of us are well aware of the technological revolution that has occurred since World War II. Equally obviously, one of our most vital national concerns was to master this technological revolution at least to the extent of our national security interests. Because of the growing complexity of technology, this task presented an unprecedented challenge both to Federal agencies having national security responsibilities and to those segments of industry upon which such agencies rely. Their joint responses in terms of technological mastery, advanced managerial techniques, and refinement of Government-industry roles created the systems approach.

What is it? In terms of general definition, it has three elements: systems analysis, systems engineering, and systems management.

The first of these embraces techniques for making a problem understandable, offering possible avenues for its solution, and establishing criteria for the selection of the best alternative.

Systems engineering consists of designing plans for the conduct of a system development program, including its schedules and costs.

Systems management consists of directing and controlling such a program to completion, on schedule, and at the prescribed cost.

Following my remarks, witnesses expert in the use of the systems approach will describe it in detail. However, I should like to make some general observations which I think bear somewhat on the question of its potential application to nondefense and nonspace activities.

First, the extent to which the systems approach is something new or radical or unique is merely one of degree. It is not an absolute science or a magical new formula or a sudden discovery or a brilliant invention. It is merely an extremely high degree of capability to evaluate, plan, and do certain complex and difficult things.

Its relevance to this discussion lies in the fact that many of the things necessary to the improvement of the quality of American life appear to require that high degree of capability.

A second important point is that this improved capability, called the systems approach, is not the exclusive province of industry. The challenges to and the responses by Government were no less staggering than those of industry, and the upgrading of industrial capability has had to be accompanied by a commensurate upgrading of the customer interface with which industry deals, in our case two agencies of the Federal Government, the DOD and NASA.

However, we must face the fact that at this point in time the advantages of the systems approach have been pretty well limited to those situations in which there has been recognition of a clear and present danger to the United States and for which there has existed an institutional framework able to exploit these advantages, in the form of agencies of the Federal Government having specific responsibilities to combat that danger.

However, the happy part of the story is that, whatever the genesis, in the course of forging these capabilities under the pressures of arbitrary and sometimes cruel national defense and space requirements, a new national asset has been created which obviously has broader application if the political and institutional keys can be found. The techniques and tools developed in fashioning an effective systems approach are in no way wedded to or limited by the purposes which gave them birth. They are somewhat complex, and while cheap, they are not inexpensive. But though superlative techniques and tools for problem analysis—and, therefore, improved bases for choice and decisionmaking—for program planning and for program management they are of a more or less abstract character.

The questions seem to boil down to these:

What is it about our national society that has permitted our Federal Government and certain segments of private industry to come so quickly and effectively to grips with the hideously complex problems of defense and space programs? And do these same characteristics of our society portend successful coping with the socioeconomic problems that lie before us?

It is readily discernible that in achieving our national defense and space objectives, in fact in being able to develop and apply the required systems approach to these problems, our society has had three things going for it:

1. A superb technological base—a reservoir the scope and depth of which is unequaled anywhere else in the world or at any time in our own history.

2. The incentives of the free enterprise system—providing constant motivation for our competitive private industrial community to further refine techniques and capabilities; in short, to come up with better ways of doing things.

3. An adaptable and flexible governmental structure which could adjust to the fulfillment of its responsibilities in a time of rapidly changing public needs.

Each of these three elements plays an essential part in our Federal Government-private industry achievement of national defense and space objectives. The first two; that is, our national technological base and the motivations of private industry, are as applicable to the improvement of the quality of our environment as they are to achievement of defense and space objectives.

The third; that is, the adaptability of our governmental structure, will be tested in a new way. Rather than the Federal Government, it will be the lower echelons of our Federal structure; that is, the State and local governments, which will have to demonstrate their creativity and adaptability, although the Federal Government will still play a role.

So now it seems to me we get to the nub of the problem. Will we, as a nation, be able to devise the formulas that will bring into play the full strength of our political system? The only significant respect in which applying the modern systems approach to socioeconomic and human environmental problems will differ from its application to defense and space problems lies in the fact that, of necessity, the public authority will be primarily at a level other than the Federal Government. Otherwise the fundamentals will be the same.

Clearly, there must be a public-private mix. Ultimate choice and control obviously will have to rest with responsible public authority at the appropriate level.

Clearly, there must also be a pinpointing of responsibility for results. One of the most valuable lessons of our national defense and space efforts has been its demonstration of the values of competitive free enterprise in this respect. A company which risks its corporate life on the success of its performance experiences a pinpointing of responsibility of the most acute order. Whether we like to accept the fact or not, experience has shown that the diffusion of responsibility in public authority rarely produces so sharp a focus.

Senator NELSON. If I may interrupt, as to the statement of yours in the middle of the page, you say:

> The only significant respect in which applying the modern systems approach to socioeconomic and human environmental problems will differ from its application to defense and space problems lies in the fact that, of necessity, the public authority will be primarily at a level other than the Federal Government.

I would like to say at this point that I think that is not quite correct. At least if you mean to the exclusion of the Federal Government, I certainly disagree. The very problems that you mentioned earlier in the statement, of water and air pollution, will demand action at the national level.

I agree with you that the question you seem to be raising is the question of the flexibility and adaptability of various units and forms of government at various levels.

Earlier you point out that the concept has been applied by NASA and DOD. This was really a relatively simple thing to do because the money was there and all they had to do was to make one decision within the Department of Defense or within NASA to apply the systems analysis approach to the problem, using all the modern techniques.

The problem, for example, of solving the pollution of the Mississippi River is, in my judgment—or to put it another way, the problem of making the systems analysis of that problem is much simpler than almost any problem that NASA or Defense has dealt with. But it is a very complicated political problem because the Mississippi River divides the Nation in half and runs all the way from up in Minnesota down to the Gulf of Mexico and involves innumerable political units of government.

But to apply the systems concept to analyze the problem and come up with a proposed solution would be a relatively simple one. What we would have to do is to analyze or compute all the factors that are polluting the Mississippi River, and then make an analysis of what it would cost to require compliance with certain water quality standards.

In St. Louis, for example, the reason this is a tough political problem is that it doesn't make any sense for St. Louis to clean up her waste because all she would be doing is cleaning the water for someone downstream to use.

But I think applying the concept of systems analysis to the problem of the pollution of the Mississippi is not exceptionally difficult to do. But implementing a solution to the problem is very complicated because of the dozens and dozens of political units within various jurisdictions and various States involved. This kind of a problem has to be dealt with on a regional and national level.

The reason I raise that in respect to your statement about emphasis on State and local level solving these problems is that on this kind of a problem the State and local government cannot do much about it unless they are under compulsion to comply with some Federal standard. Then they might do it.

Mr. HARR. Mr. Chairman, I am not presuming, and it would be presumptuous for us to suggest from your vantage point that we have any hard answers on the political formulas or the scope in terms of political jurisdiction of the respective areas that will have to be involved in the solution of such problems.

It is certainly true, as you say, that identifiable ones among them are national in scope and are interrelated one to another.

I think the point that comes home to us from a supplier's point of view, from a private industry point of view, is as you turn from rather pure national problems such as defense and space efforts, in which lower echelons of our Federal structure are not involved at all, really, except as jurisdictions within which factories and plants are placed, you do bring into play to a degree not present before the question whether these lower levels of public authority can adapt themselves to this need effectively, either constructively and positively taking the initiative, or at least being able to accommodate to some broader scheme.

Senator NELSON. The reason these bills were introduced at all was that some people feel that this concept which has been utilized so successfully in the aerospace industry which you represent, in defense, in

NASA, can, in fact, be applied successfully to many social problems that confront the country, that is, water and air pollution for example.

Would you not agree that if the aerospace industry were asked, for example, to apply this concept to the Mississippi watershed and all of its tributaries and come up with an analysis of what the problem is and a proposed solution, would you not agree that you would have that capability to handle that type of problem as well as you have handled a number of others?

I am not talking about the politics side. The implementation would be the tough part.

Mr. HARR. I certainly would, Mr. Chairman. I get pretty oratorical on that subject as I go on in my statement. But picking out the points that I think are fundamental as to whatever formula is involved, I think it is also clear that regardless of what level of public authority is involved, it will remain true that the pertinent public authority must bear the responsibility of knowing what it wants.

Those responsible to the public must put the rabbit into the hat. Otherwise the system breaks down. Not only is it inappropriate for the private contractor to go beyond a certain point in this part of the act, but it is also beyond his scope and undesired by him.

We have seen in the defense and space business that independent, nonprofit think groups can effectively supplement the Government's in-house analysis capabilities, and that private industry can contribute by expanding and sharpening alternatives, by "selling" privately sponsored technological advance, by advising and critiqueing, and by aiding in the production of tools and techniques for systems analysis. But not only the weighing of alternatives but also the primary job of systems analysis must be wholly and closely under the control of the user.

There will be many differences between the problems of establishing effective public-private interfaces at the State and local level and those which were involved in creating the existing effective interfaces for our national defense and space programs.

Senator JAVITS. Mr. Chairman, I have one problem, an executive meeting of the Government Operations Committee. Could I ask one question at this point?

Senator NELSON. Certainly, Senator Javits.

Senator JAVITS. Naturally, we are trying to work out a plan—which I wish to be part of—to deal with this very critical problem of having the Government help American private enterprise and technology develop the necessary manpower to do this job.

Have you told us, are you telling us, or will you tell us, which of these two approaches seems to you to be the best calculated to advance the project sooner and in the most effective way; that is, of the two approaches in the bills which are before us, S. 430 and S. 467?

We have the problem of choosing a course. I don't think there is much question about the justification for moving in this field, as Senator Nelson has properly said. But I do think we have some question about which course to take, whether to take the course of moving right into a program, which is the Nelson bill, or whether to take the course of establishing some overall commission and letting it develop a program.

Mr. HARR. Senator, I don't really believe we have the answer to that. I think the conclusion of the remarks I have prepared deals with

the question of various elements to be involved. Certainly experimentation will be involved whichever course is taken.

This is one of the primary lessons we learned working so closely with the Federal agencies; that is, that working out the exact forms and so forth involves considerable experimentation no matter what direction we go. What I have been trying to say to the industry people whom I represent is that they, too, have a responsibility for pushing this one step forward; that is, taking the initiative where the knowledge that they have acquired through their respective corporate perspectives points a way to solve some problems that some civic authority, either Federal or sub-Federal, has not undertaken.

What I am saying is that I don't think any of us really knows any one pat formula to do it. I think we all feel that if each element of the picture, and this would include, certainly, the industry and the Federal Government, but also initiatives at the lower levels, pushes it along—and that is what is happening now; it is being pushed along at all levels—the important thing is to get going because we have a wonderful asset here.

Senator JAVITS. Taking your industry, the aerospace industry, does it have any feeling that it can operate better or get further with either one of these alternate plans?

Mr. HARR. The simplest format, of course, is the Federal Government. There is no question about that. A lot of ground has been broken there, a lot of experience exists. The lines are politically much more direct, and so forth. We are very experienced in our industry in dealing within the Federal Governmental contract structure on large programs.

Senator NELSON. Some time last year, Senator, I discussed this with Congressman Bradford Morse, and Senator Dominick, and again this morning. We are pretty generally agreed that we can combine both concepts.

I certainly would agree that the idea of a national commission to do some evaluating of where best to start and how best to utilize the technique, with an overall view of the total problem, is a very valuable idea. But also, since we do know what the concept is, it can be applied, as it is being applied in various parts of the country now, to specific problems. We could combine on a bill using both concepts.

Senator JAVITS. Thank you, Mr. Chairman.

I would like the witness to do one thing for us because, again, we need great specificity.

You are urging your industry, the private sector, to dovetail closely with Government. Will you undertake for your association to study these two bills and give us in detail precisely what you think you can do in the framework with the merged plan which the chairman has outlined?

If you find there are any deficiencies or any areas which would disable you from cooperation or close coordination and contribution because of the terms of the law, will you tell us?

In short, I certainly feel it should be our purpose to have a legal structure which has the maximum receptivity to private enterprise contribution, participation, and initiative.

I would invite, as one Senator, and my guess is my colleagues would have no difference with me, that you study this statutory plan as the chairman has just laid it out, and give us your suggestions: One, as

to whether it does facilitate the relationship with your industry that you think is desirable, and, second, if not, what needs to be done in the law to facilitate it.

Is that clear? I think that we need specificity. Also, frankly, we need some commitment by the industry. It would be very helpful to us at this stage in getting this legislation passed. It is not enough to come here and just say, "We like it." You have to tell us how you are going to help implement it. No law means anything unless it is actually going to work and has the resources and the backing that will make it work.

I want to know from you what you are going to do to help this work, and whether the legal framework which our chairman has laid out accommodates your concepts of how the aerospace industry can contribute to this effort.

I bar nothing, not even money, facilities, or management. You tell us what you want to do in this respect, and whether what you want to do is accommodated by the statutory scheme our chairman has laid out.

Mr. HARR. I will be glad to try, Senator, up to the point to which we can properly go.

Senator JAVITS. May I ask the chairman for that information?

Senator NELSON. Certainly. Can you have that in soon?

Mr. HARR. Yes, Mr. Chairman. Actually, I can address myself, I think, somewhat to that proposition at this point because we are in business. Primarily we are in the Government business. One of the things I think that is most notable that has occurred, although, perhaps its occurrence has developed somewhat imperceptibly, is the fact that a large segment of private industry—which includes a good part of the aerospace industry and other industries—has come to have confidence that it can operate in conjunction with public interfaces over a substantial period of time and still make a profit, still live up to its first responsibility in that regard.

That is very different from what you would have found 10 years ago, both on the Government side and on the industry side.

Living together in these large and complex defense and space programs there has been considerable expertise developed as to what are the proper parameters and so forth.

The point we are trying to make here, and perhaps I have overstated it in my statement, is that when you leave that portion of Government with which there is such experience, and try to get on to other areas of government, or into other areas of government, at the lower levels, if that be necessary, such as a city, a municipality which wants a systems approach to this, that or the other part of its problems, or a region or a State, you are breaking new ground on both sides.

We try to identify from our experience on the industry side of the industry-Government relationship what are the fundamentals of the relationship that have made it work and where these fundamentals can be found elsewhere, or whether they exist elsewhere.

I think the chairman put his finger on one key point which is that for a large Federal agency such as Defense or NASA, given the authority and appropriations from Congress, the decision to go ahead is a pretty simple one. After that, it just becomes a matter of doing the job, however complex.

Centralization of authority of most public authorities below the level of the Federal Government is often not quite that clearly defined and is often interrelated with that of sister cities, sister States, or sister regions in a way that further complicates the picture. We think the problem has to be solved there, however.

We think that the initiatives, the commitments, and the investment of desire and will, have to rest at least in substantial part with the public authority which has jurisdiction over the area most directly concerned. We recognize, of course, that our city, State, and regional structures are often not well tailored to cope systematically with the problems with which we are now faced.

Part of the ingenuity and creativity that will be demanded is for all sides to address themselves to finding a way to apply the systems approach. We think far and away the best way to proceed is through contract with private industry, but in tasks measured by the scope of those jurisdictions.

Senator JAVITS. I thank the Chair.

Senator NELSON. Senator Javits has been a strong advocate, and I agree with him, of utilizing the contracting techniques to assist the Government in solving these problems.

For example, if the Department of Interior, which is responsible for water in this country, interstate waters, were to ask your industry, or any industry of competence, to set up a team to work with them in evaluating the total water problem in this country, with your industry or another one doing this on a private contracting basis, you wouldn't find any problem in working in that area, in this way, with the Government, would you?

Mr. HARR. I would like to answer that very carefully.

I think we would give a positive answer to such a proposition, but there would also be a lot of other groups scrambling for attention in the form of think groups organized for research purposes and so forth.

Senator NELSON. I am not suggesting it might only be done by your industry. There might be a private contract with a university. There are all kinds of private think groups.

The question is, would you find it feasible to work with the agencies in tackling this kind of a social problem?

Mr. HARR. I think that would in substance not differ all that much from the kind of problems that are now presented.

Senator JAVITS. Thank you very much, Mr. Chairman.

Senator NELSON. Thank you, Senator.

Mr. HARR. To the degree to which the effort to transfer structures and techniques that are now being applied to broader human environmental objectives involves the introduction in one degree or another of participation by lower levels of the Federal structure, there are obviously going to be differences from what we have been used to.

However, I think it is very important to keep in mind the great positive assets we have to work with.

In the highly developed techniques comprising the systems approach we have a capability which, while not a magic new formula, is so different in degree from what has gone before as to be different in kind. It provides us the precious capability to assemble, digest, evaluate, decide, plan, program, and manage an almost infinite number of factors, taking advantage of all available information. It permits

us to provide public authorities with an intelligent choice among alternatives and these public authorities in turn to communicate these alternatives in comprehensible fashion for purposes of public participation in decisionmaking. It permits decisions to be made in time to be effective, an increasingly precious characteristic in these complex and fast-moving days. Finally it permits intelligent choice among alternatives to be made at a time of minimum investment of resources.

We have an unsurpassed and expanding national technological capability and, as we have learned elsewhere, technological advance breeds technological advance in the areas in which it is applied, almost geometrically.

This is one of the unprovable but empirically demonstrated experiences that we have had in the defense framework and in the whole aviation framework, that as you do apply your superb technological base, taking the Nation as a whole, to one of these areas, it breeds technological advance in that area very rapidly, which I think is significant in terms of transferring it to other socioeconomic purposes.

We have a reservoir of private industrial experience in joint public-private systems approaches coupled with a recognition by private industry that participation in such ventures is wholly consistent with its profit motive. In fact, given the scope of the problems that lie before us and the virtual certainty that many of the largest enterprises of the future will involve public-private joint endeavors, the wisest among us already know that some of the big markets of the future will lie in such areas.

But above all we as a nation are blessed with a flexible and creative multilevel political structure to serve as a vehice for addressing ourselves imaginatively and effectively to the solution of whatever problems beset us.

In short we've got all the ingredients of a formula that can marry the three great advantages of our national political and economic system—unparalleled technological capability, free enterprise incentives and a Federal political structure affording opportunities for in-depth political creativity—toward the improvement of the quality of American life.

Perhaps, however, there is a single lesson that has been learned from our defense-space experience that is most pertinent to the subject of these hearings. That is, that the precise methods of State and local use of a public-private systems approach have to be worked out by experimentation. DOD and NASA have arrived at a point of considerable sophistication and expertise in this regard. They did not do so overnight or without considerable experimentation—and perhaps theirs was an easier task than authorities below the Federal level of government will face.

In the course of this experimentation they developed a high degree of appreciation of the strengths of the systems approach—and of its limitations—and of the optimum roles, all factors considered, of the Government on one hand and of private industry on the other.

Similar experimentation must be undertaken if we are to expand the utility of the public-private systems approach to levels below the Federal Government. We must be most careful to walk before we run, for there are as many added complexities to operating below the national governmental level as there are differences between the needs, structures and capabilities of each subdivision of our Federal structure.

For most of the large identifiable problems today the modern systems approach is obviously the essential tool. It remains for us as a nation to find the various political formulas for its application wherever needed. Whatever the cost it will be far cheaper to solve these problems than not to, and far cheaper to solve them well than to muddle through. It will also be much easier to answer the difficult question, "How can we?", than it will be to answer the impossible question, "Why didn't we?"

Mr. Chairman, I have with me two experts from aerospace companies, Mr. Ward Dennis of the Northrop Corp. and Mr. H. L. Wheeler of North American Aviation, who have prepared an example in detail to describe what, in the defense-space business, the systems approach really boils down to.

Senator NELSON. We will take a brief recess before proceeding with their statements.

(A brief recess was taken.)

Senator NELSON. The subcommittee will be in order.

Mr. Harr, for the record, would you introduce and identify the two witnesses you have with you?

Mr. HARR. I have two witnesses, Mr. Ward Dennis, on my right, of the Northrop Corp., and Mr. H. L. Wheeler, of North American Aviation, both of whom have long experience in the application of the systems approach.

Senator NELSON. You may proceed in whatever fashion you wish.

Mr. DENNIS. We prepared a dual presentation for you this morning.

I am going to talk on the systems process in outline form which has been developed by the Department of Defense which has application as a process to other national problems that we have.

Mr. Wheeler is going to follow on segments of my presentation with an example of application to a current military problem to illustrate the complexity and all the factors that have to be considered.

Mine is intentionally oversimplified to get down to key elements and key points in the systems approach. Mr. Wheeler's example is much more complicated to really portray the complexity of the problem that does exist.

First is the objective of the systems approach, to arrive at the best operating solution to a complex problem on time and at a reasonable cost, beginning with a general understanding of the problem.

First, the systems approach starting with the general understanding carries through to the point where there is a solution to the operation. It doesn't stop simply with the analysis of the problem, but carries through to where the solution is implemented and is operative.

Second, as you have well pointed out, this is not a new technique. This has been going on for thousands of years. What has happened in the last decade and a half or so is that the techniques and capability for analyzing complex problems have accelerated a great deal and today they are a very effective approach to analyzing a complicated problem on a major scale and it is a very exciting tool to apply to some of our national problems outside of the Defense Department.

Mr. Wheeler will pick up at this point and start with a definition of the problem of his example.

If you have any questions as we go along, please feel free to ask.

Senator NELSON. The charts that you speak of will be printed in the record at this point.

(The charts referred to follow:)

THE AEROSPACE SYSTEMS PROCESS

JANUARY 24, 1967
PRESENTED
BY
THE AEROSPACE INDUSTRIES ASSOCIATION
WASHINGTON, D.C.

SYSTEMS APPROACH
OBJECTIVE

ARRIVE AT BEST OPERATING SOLUTION TO A COMPLEX PROBLEM

ON TIME & AT A REASONABLE COST

BEGINNING WITH A GENERAL UNDERSTANDING OF THE PROBLEM

SYSTEMS APPROACH
STEP ONE

- SYSTEMS CONCEPT DEFINITION - BEGINNING WITH GENERAL UNDERSTANDING OF PROBLEM
  - DEVELOP A DETAILED UNDERSTANDING
  - DETERMINE ALTERNATIVE WAYS OF SOLVING THE PROBLEM THROUGH SYSTEMS ANALYSIS TECHNIQUES
  - ARRAY RESULTS FOR DECISION ON ONE OR MORE PREFERRED SOLUTIONS

SYSTEMS APPROACH
STEP TWO

- PROGRAM DEFINITION - BEGINNING WITH ONE OR MORE PREFERRED SOLUTIONS
- SPECIFY SYSTEM DETAILED CHARACTERISTICS UTILIZING SYSTEMS ENGINEERING
- DETERMINE TOTAL COST FOR PROGRAM
- DETERMINE SCHEDULE FOR IMPLEMENTATION

SYSTEMS APPROACH
STEP THREE

SYSTEM IMPLEMENTATION

ENGINEER, PRODUCE, EMPLACE AND/OR OPERATE THE FINAL SOLUTION

UTILIZING SYSTEMS MANAGEMENT TECHNIQUES IN ACCORDANCE WITH

PREDETERMINED COSTS & SCHEDULES

WHO ACCOMPLISHES THESE STEPS?

SYSTEMS CONCEPT DEFINITION

DEPARTMENT OF DEFENSE, ALLIED ANALYSIS & EVALUATION ORGANIZATIONS, WITH SUPPORTING STUDIES & TECHNICAL DATA FROM INDUSTRY

PROGRAM DEFINITION

INDIVIDUAL CORPORATIONS OR INDUSTRY TEAMS WITH A GOVERNMENT PROGRAM MANAGEMENT AGENCY

SYSTEM IMPLEMENTATION

ARMED SERVICES DEPARTMENTS & INDUSTRY THROUGH PROGRAM MANAGEMENT OFFICES

HOW ARE THESE STEPS FUNDED?

SYSTEMS CONCEPT DEFINITION

DEPARTMENT OF DEFENSE OPERATING BUDGETS, CONTRACTUAL ARRANGEMENTS WITH SUPPORT ORGANIZATIONS, & SMALL STUDY CONTRACTS WITH INDUSTRY

PROGRAM DEFINITION

FIXED PRICE CONTRACTS WITH INDUSTRY

SYSTEM IMPLEMENTATION

CONTRACTS WITH INDUSTRY HAVING VARYING DEGREES OF INCENTIVES DEPENDING ON RISKS INVOLVED

HOW ARE INDUSTRIAL TEAMS SELECTED?

SYSTEMS CONCEPT DEFINITION

BASED ON REQUEST FOR PROPOSALS, CONTRACTORS DESCRIBE THEIR EXPERIENCE, PERSONNEL & PRELIMINARY APPROACH

PROGRAM DEFINITION

BASED ON REQUEST FOR PROPOSALS, CONTRACTORS DESCRIBE THEIR SYSTEM DEFINITION PROCEDURE, TECHNICAL DEVELOPMENTS & CAPABILITY TO UNDERTAKE SYSTEM IMPLEMENTATION

SYSTEM IMPLEMENTATION

BASED ON RESULTS OF PROGRAM DEFINITION, PARTICULARLY SIGNIFICANT TECHNICAL FEATURES & COST/EFFECTIVENESS OF THE TOTAL SYSTEM

EXAMPLE OF THE SYSTEMS PROCESS

HYPOTHETICAL EXAMPLE

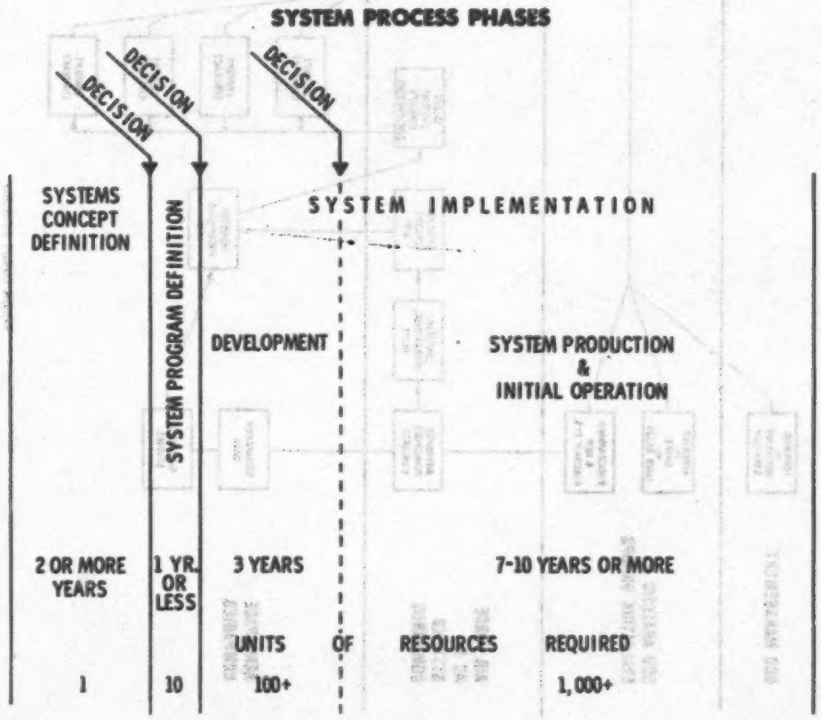
TACTICAL LOGISTICS SUPPORT SYSTEM

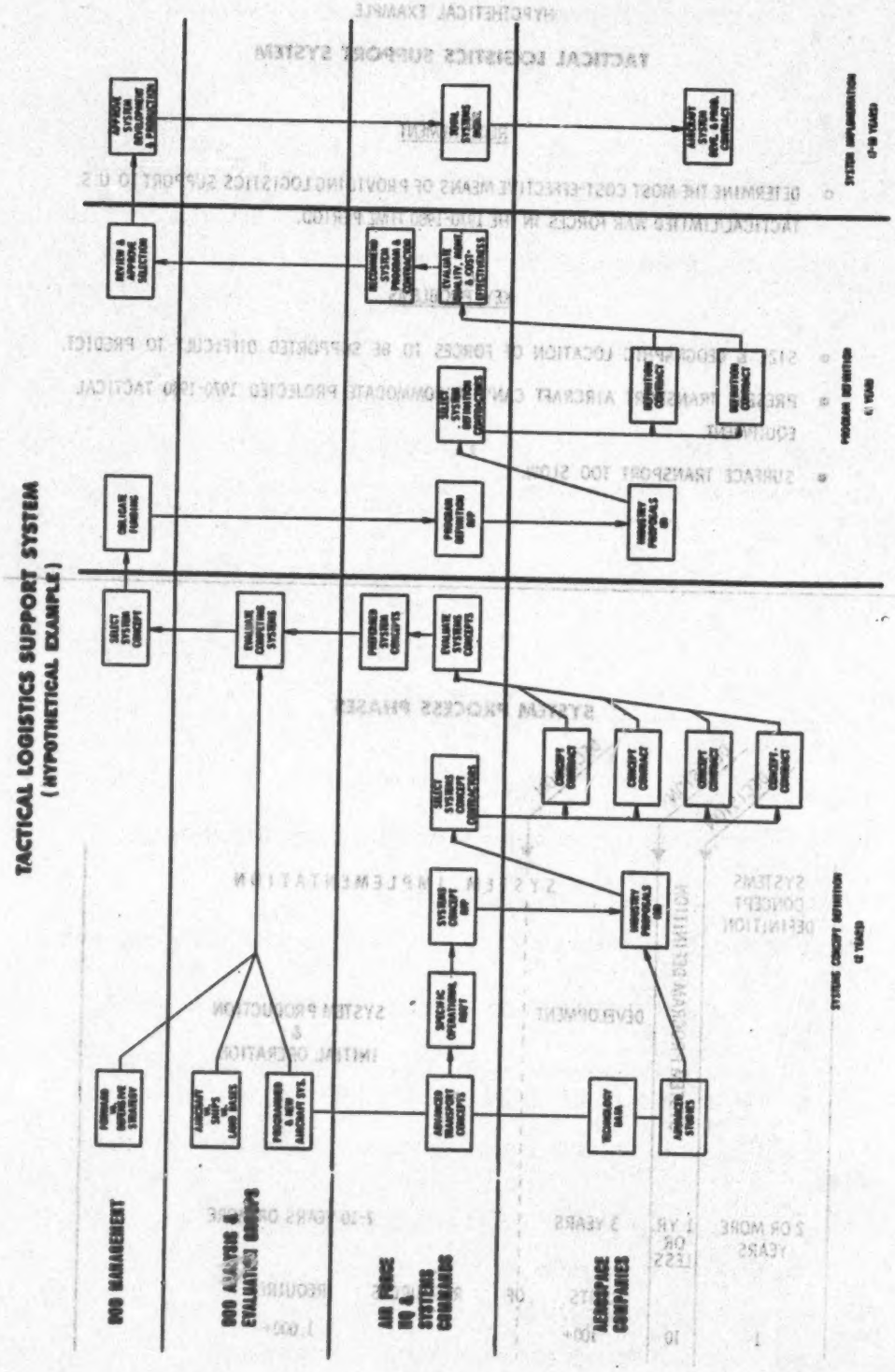
REQUIREMENT

- DETERMINE THE MOST COST-EFFECTIVE MEANS OF PROVIDING LOGISTICS SUPPORT TO U.S. TACTICAL/LIMITED WAR FORCES IN THE 1970-1980 TIME PERIOD.

KEY PROBLEMS

- SIZE & GEOGRAPHIC LOCATION OF FORCES TO BE SUPPORTED DIFFICULT TO PREDICT.
- PRESENT TRANSPORT AIRCRAFT CAN'T ACCOMMODATE PROJECTED 1970-1980 TACTICAL EQUIPMENT.
- SURFACE TRANSPORT TOO SLOW.




TACTICAL LOGISTICS SUPPORT SYSTEM
(HYPOTHETICAL EXAMPLE)
DOD MANAGEMENT
DOD ANALYSIS & EVALUATION GROUPS
AIR FORCE HQ & SYSTEMS COMMANDS
AEROSPACE COMPANIES
SYSTEMS CONCEPT DEFINITION
6 YEARS

PREREQUISITES FOR ENTERING PROGRAM DEFINITION PHASE

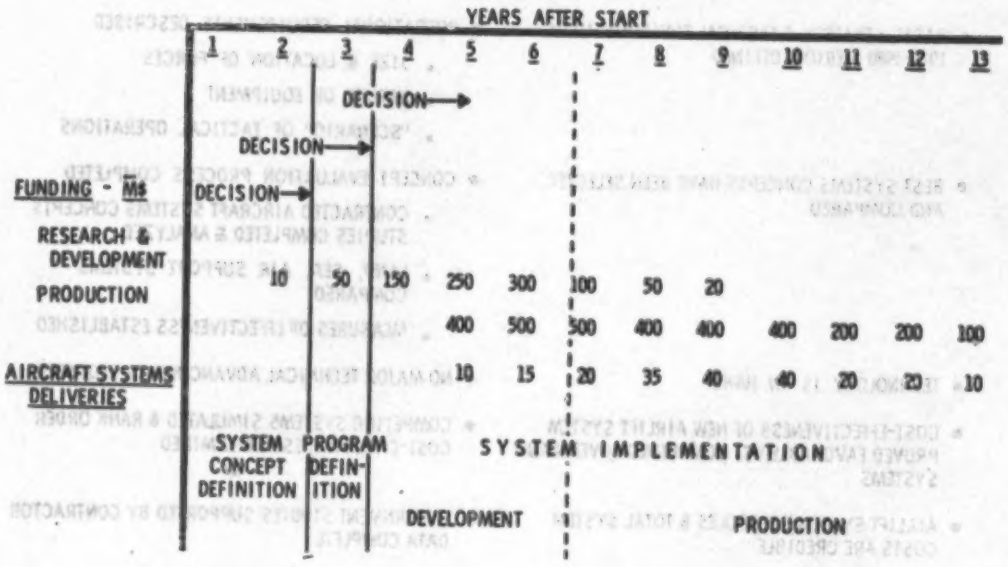
PREREQUISITE	SYSTEMS ANALYSIS TASKS
• BASIC STRATEGY & TACTICAL ENVIRONMENT OF 1970-1980 PERIOD DEFINED	• OPERATIONAL REQUIREMENTS DESCRIBED • SIZE & LOCATION OF FORCES • NATURE OF EQUIPMENT • "SCENARIO" OF TACTICAL OPERATIONS
• BEST SYSTEMS CONCEPTS HAVE BEEN SELECTED AND COMPARED	• CONCEPT EVALUATION PROCESS COMPLETED • CONTRACTED AIRCRAFT SYSTEMS CONCEPTS STUDIES COMPLETED & ANALYZED • LAND, SEA, AIR SUPPORT SYSTEMS COMPARED • MEASURES OF EFFECTIVENESS ESTABLISHED
• TECHNOLOGY IS IN HAND	• NO MAJOR TECHNICAL ADVANCEMENTS REQUIRED
• COST-EFFECTIVENESS OF NEW AIRLIFT SYSTEM PROVED FAVORABLE VS. COMPETING GOVERNMENT SYSTEMS	• COMPETING SYSTEMS SIMULATED & RANK ORDER COST-EFFECTIVENESS DETERMINED
• AIRLIFT SYSTEM SCHEDULES & TOTAL SYSTEM COSTS ARE CREDIBLE	• GOVERNMENT STUDIES SUPPORTED BY CONTRACTOR DATA COMPLETE

PREREQUISITES FOR ENTERING SYSTEM IMPLEMENTATION PHASE

- o THE RECOMMENDED SYSTEM IS DESCRIBED IN DETAIL
  - PROPOSED NEW DESIGNS & DEVELOPMENT PROGRAMS WITH TEST PLANS TO DEMONSTRATE FEASIBILITY
  - FORESEEABLE TECHNICAL PROBLEMS & PROPOSED SOLUTIONS INCLUDING BACK-UP EFFORTS
  - TIME/COST/PERFORMANCE COMPARISONS WITH MAJOR ALTERNATIVE SYSTEMS & INFORMATION ON THE OPERATIONAL & COST-EFFECTIVENESS OF EACH
- o PERFORMANCE SPECIFICATIONS FOR EACH END ITEM REQUIRED FOR OPERATION & MAINTENANCE OF THE SYSTEM ARE COMPLETE
- o PROPOSED PRODUCTION SCHEDULE & COST DATA COMPLETE
  - DETAILED COST BREAKDOWN RELATED TO PERT/COST
  - ESTIMATES OF TOTAL PROGRAM COST TO THE GOVERNMENT (10 YEAR PERIOD)
  - FIRM COST PROPOSALS FOR DEVELOPMENT & FIRST PRODUCTION

TACTICAL LOGISTICS SUPPORT SYSTEM

(HYPOTHETICAL EXAMPLE)



SUMMARY

SYSTEM TECHNIQUES AS ONE BASIS FOR EXECUTIVE DECISION

- CONCEPT DEFINITION - SYSTEMS ANALYSIS PROVIDES
  - ALTERNATIVE APPROACHES TO SATISFY REQUIREMENTS
  - RELATIVE EFFECTIVENESS OF EACH
  - PROBABLE EXTENT OF GOVERNMENT OBLIGATIONS
- PROGRAM DEFINITION - SYSTEMS ENGINEERING PROVIDES
  - PREFERRED SYSTEM DESIGNS WITH ALTERNATIVES
  - COST/EFFECTIVENESS OF EACH
  - FIRM PLANS AND SCHEDULES FOR DESIGN & DEVELOPMENT
- PROGRAM IMPLEMENTATION - SYSTEMS MANAGEMENT PROVIDES
  - PLANS AND COSTS FOR ORDERLY SYSTEM DEVELOPMENT, PRODUCTION AND OPERATION
  - TIMING AND NATURE OF OBLIGATIONS
  - ASSURANCE OF COST AND PROGRAM CONTROL

Mr. WHEELER. We selected an example that we felt would be both within our ability to describe in a period of time that we have, and one which we felt would be sufficiently clear to trace the process.

We also picked an example which we feel has a good basis for comparison with problems outside the Department of Defense sphere.

This example is a hypothetical one of a tactical logistics support system. However, it is drawn from real experience with Department of Defense programs. So although this is not in itself an actual program, it does represent a real problem and set of events.

Here we set up a requirement as a basis of getting a systems study started. The problem put in the form of a requirement was to determine the most cost effective means of providing logistics support to U.S. tactical limited war forces in the 1970–80 time period. This was the very general requirement which initiated the systems analysis proceeding ultimately to a system.

At this point in the example, it was noted that three problems were of significant importance: First, the sizes and geographic location of forces during the 1970–80 time period would be difficult to predict. A common problem, as you were mentioning earlier, Mr. Chairman, in predicting the environment many years in the future.

Secondly, in examining the means of transport available in transporting material and people in the military sense, it was forecasted that the existing aircraft and other logistics systems would not be able to accommodate equipment of this advanced time period.

Thirdly, for our problem of rapid disposition of forces and equipment, it was evident that existing surface transport, existing of some years ago, was too slow to probably solve the problem.

Here we have an example, then, of the beginning of the requirement to begin a systems analysis activity.

Mr. DENNIS. We have divided the systems approach into three steps. These are sequential steps that are followed.

The first step is the systems concept definition. The systems concept definition is beginning with the general understanding of the problem, first to develop a detailed understanding, second to determine alternate ways of solving the problem through systems analysis techniques, and third to array results for decision on one or more preferred solutions.

There are two points here. The most critical part of the whole systems approach and in step 1 is developing a detailed understanding of the problem. We talked about this earlier. What is going to happen in the future? The systems approach is applied to future problems. What is the situation going to be in 1970, 1980?

If the detailed understanding of the problem is not developed first, a very good engineering solution can be prepared to solve the wrong problem.

So this is probably the most critical step of the whole process.

Second is to determine alternate ways of solving the problem through systems analysis techniques. These are the techniques that have been developed in the last decade or so in the aerospace industry and in defense work, in which mathematical models are used to simulate the actual problem that exists, computers are used to run many hundreds of solutions through to arrive at the best solution to solve the problem.

The final step in the systems concept definition is to array results for decision on one or more preferred solutions. Here is where the technique of assessing cost and effectiveness, and, as the term is used in the Department of Defense, the cost-effectiveness criteria, is used to select one or more preferred solutions for the next step.

Mr. WHEELER. We have, as a mechanical aid to tracing the process, a flow chart, and a more detailed chart for your closer examination, Mr. Chairman. They are also in the material made available to the press.

In this flow chart, the number of boxes and the complexity in detail is not necessarily significant. What is significant, I think, to us is that in our example a very large number of steps and some key decisions were accomplished in these two steps where Mr. Dennis started, with step 1. All of them lead to the point where the Government could be confident that they have the best solution to the systems problem.

So to begin step 1 in our example, a series of six study areas were undertaken, all looking at different aspects of the general military logistics problem.

First, are the basic considerations of policy and strategy, not just related to the problem I will describe further, but to the whole question of logistics support of military forces. Here the study was directed to the question: Is it possible to change our basic approach which we have used for a great many years; that is, of landing a small number of forces, very slowly building up and providing supplies to those forces, or, rather, is it possible with a new approach to transport rapidly a very significant quantity of men and materiel to any point in the world?

That is the general study which would ponder the question of policy.

At the same time, there were general studies, systems analyses, looking at what in the gross sense are systems that could satisfy this requirement. Is it best, for instance, to pre-position equipment or supplies at land bases? Is it best to pre-position them on ships? What is the composition of the aircraft fleet which could be used? This is in the same sense that civil transportation studies attempt to look at very gross systems in the beginning so that nothing is overlooked.

At the same time, possibilities in combinations of airlift systems were studied in, again, the gross; but with a good deal more detail there being studies of what is the state of the art of the late 1960's and early 1970's in advanced transport aircraft, and how advanced an aircraft and all the systems which go with it, logistics systems, support, maintenance, and so on, is feasible in an engineering sense and also practical of application.

These studies, the four I just mentioned, conducted by the Government, supported by not-for-profit and in-house agencies, were done. At the same time, there was a great deal of technology information supplied by aerospace industrial contractors and also the results of their own advanced studies.

So these studies pursued a course of looking at the same gross problem in a very large number of ways. Out of this, in our example, came two principal products of considerable importance to us. One was in the systems analysis process finding a way by which we could measure the effectiveness of each of these candidate systems to accomplish an airlift mission.

That systems analysis job produced measures of cost effectiveness. I will do my best to give a very simple example.

As in a socioeconomic problem in systems analysis, one of the most difficult things is finding these measures that truly give you an answer as to what is effectivity, what does it mean when compared with cost, and truly can the standard be used to compare systems of quite different physical characteristics.

In this case, it was felt necessary to compare the use of a worldwide logistics system on two different bases. One is considering using this logistics system in a peacetime operation. What measure, then, of effectiveness should we use?

In this case, it was determined most practical to use a measure of effectiveness rather like that which commercial airline operations use; that is, the operating cost and all other costs per mile for the life of the fleet over, let's say, a 15-year period.

That gives you, then, a peacetime kind of measure of effectiveness of the system.

Secondly, because this is a military system, looking at an emergency situation and then considering the principal measure of effectiveness is how many tons per day can be moved to a given place on the earth, and considering that this system must be self-contained and able to operate in a number of different environments, that system operation then is measured against its cost per day.

So this determining of standards of cost effectiveness is a principal part of this step 1, primarily a systems analysis process.

Second, out of this process came the selection of an airlift system which seemed to be that which was most effective when compared with the two cost-effectiveness measures I just described.

Once this general concept had then been determined, the Government wrote out requests for proposals to describe requirements to our industry to do systems concept studies. The industry job was to tell the Government what are the possible airlift alternatives, and give the Government comprehensive information on what it is likely to cost and how effective it will be.

In our example here, some 10 industrial companies responded with proposals to do these system concept studies, and the Government selected four such contractors. These contractors were to provide in all probability, and in this model in fact, quite different approaches to solution of the airlift problem.

After these contracts were completed in a 6-month period, the Government agencies then evaluated each of these airlifts concepts again against the standards or the measures of effectiveness which I just described, and at that point compared the effectiveness of this possible new airlift system with the basic considerations of alternatives of land basing, sea basing, the contribution of each such system to a possible change in strategy and general policy related to tactical war.

It was concluded then that the airlift system, when reviewed against all other competing systems, was the most effective way to solve one large aspect of the logistics problem. At that point, a critical one, this system concept was then selected. At that point we now have a basis for beginning the second step of the process.

Mr. DENNIS. Step 2 of the systems approach is called program definition. This begins with one or more preferred solutions that have

been arrived at as a result of the systems analysis step, to specify system detailed characteristics utilizing systems engineering techniques, determine the total cost for the program, and determine the schedule for implementation.

In this step the preferred solutions are detailed and the specifications written as to exactly what that solution is. A cost is projected, and a schedule for implementation is projected.

In the last 10 years or so, the systems engineering techniques have been able, through this process, to move forward on these very complex problems. Systems engineering here is grouping together large, diverse elements of technology, resolving the interfaces, seeing that they all work together, predicting reliability, forecasting personnel, training requirements, and the ultimate total cost of the system throughout its lifetime.

At the conclusion of step 2, sufficient information is known that a contract for implementation can be let. So this is the preparatory step for contract implementation.

Mr. WHEELER. In our example, as is common practice in Defense Department systems processes, before entering this second step, that of actually defining a real program, the Government, itself, had to review its activities and those of industry in this first step to see if all of the necessary prerequisites were complete.

In our example, it was determined that in looking at the tactical environment of the 1970–80 time period, that operational requirements had been described in sufficient detail to tell the Government what the size and location of forces were likely to be, what the nature of equipment and support requirements were likely to be, and then in our business terms a scenario had been written, or a series of them, depicting what worldwide military operations were likely to be.

This gave, as in any other system problem, an environmental basis to proceed. We had some notion at this point of the general environment in which the system would be operating.

Secondly, it was determined that all of the systems concepts considered were a sufficient array to have covered all aspects of the problem. These concepts, then, reviewed, with a concept evaluation process completed and using industry studies and Government studies, arriving at the conclusion that I mentioned before: that an airlift system is most practical.

At this time it was also determined that there were not major technical advancement problems that were likely to impede development of an airlift system.

Lastly, the Government, all through this first step, had been provided a great deal of cost and performance and schedule information by the four contractors participating in concept formulation studies. This gave the Government a basis for defining in some detail the likely financial obligations of the Government.

In this example, as we enter step 2, the program definition phase, the Government determined that, in fact, it was possible, it was feasible, to obligate funding and proceed with a system.

So at this point funds, originally some $300 million for development, but contemplating a program of in excess of $1½ billion, were obligated. Shortly following this, the Government completed its very detailed requirements for program definition proposals from industry.

This example of program definition had some 1,000 pages of specifications to which the contractor would respond. It was a very detailed definition that would enable the contractors to understand the job the Government required of them.

In our example, although we had proposals from 10 members of the industry in the first step, we find now proposals from only five such members. Here the difference in number is that fewer contractors felt it possible to respond to the total requirements that they developed from the very detailed work statement, so we have come down to a smaller number of companies who now submit proposals to the Government to actually define the system in considerable detail.

These proposals were then evaluated by the Government with a view of which contractor can respond best in defining the system. At this point, two such contractors were selected, based upon their ability to develop and produce a system.

Again, the system approaches that were likely were evaluated based upon the cost-effectiveness measures I described earlier.

The contractors selected completed a 6-month contract definition program. At that point they produced a very substantial volume of data to the Government to give an adequate definition of the system they proposed, its costs and its nature. These were compared for effectiveness both in a peacetime and in an emergency operation, and a contractor recommended for selection based upon his having the most efficient system in a cost-effectiveness sense, and one which had the best number of desired technical features.

Mr. DENNIS. The third and last step in the systems approach is the system implementation step. This is where the solution to the problem that was defined in the program-definition phase is actually implemented. Here we engineer, produce, emplace, and/or operate, depending on the characteristics of the system, the final solution utilizing systems management techniques in accordance with predetermined costs and schedules.

Again, in this phase, the systems management techniques developed in the Defense Department are very critical to the success of the implementation phase, techniques like PERT cost, where you have an ability to predict the final schedule and final cost of the total system as the system is being put into place and being operated. This is the third and last step of the systems approach.

Mr. WHEELER. In our example, we had a group of Government prerequisites satisfied in going from step 1 to step 2, and in the same respect, in this example, and in common practice, a group of prerequisites to allow the Government to proceed from program definition into implementation of the system were reviewed. These prerequisites in our case were a recommended system design described in sufficient detail and with development programs and necessary testing described so that the Government could have confidence in a contractor or teams of contractors to carry out the implementation of the program.

Secondly, foreseeable technical problems have been described in considerable detail. In our example, these did not appear to be of large order. Solutions, however, to possible technical problems were proposed and ways of responding to Government needs, should the Government make some changes in system requirements as the program moved along.

Thirdly, comparisons in a time sense, in the cost sense, and in effectiveness sense were made of several airlift system designs, showing their features in a comparative sense and providing information on how much each would cost and how effective it was, and comparing those, in turn, with a recommended system design.

That recommended system had detailed specifications for each end item; that is, each piece of physical equipment, training procedures, maintenance procedures, and so on, necessary to operate the system.

Lastly and very significantly, production information on schedules and costs of sufficient detail that they could be compared one system to another were completed. Mr. Dennis mentioned PERT. Cost systems in this case were completely drawn out to the point that the Government could look at variations of time and its effect on cost, and vice versa.

Then estimates of a 10-year-production period of the program and the developments preceding it were provided and also firm cost proposals to the Government for development and then first production quantities of the airlift system.

At that point, the Government had sufficient information to begin a rather substantial program backed up with also very substantial data.

Mr. DENNIS. This is a summary chart of these three steps that I will show you next: systems concept definition, program definition, and the system implementation.

Generally, in major systems in the Department of Defense, the systems concept definition takes a period of about 2 or more years to fully understand the problem and look at the alternative solutions.

The systems program definition is on the order of a year or less.

Systems implementation varies depending upon the type of program involved. In the particular example that we are talking about here, the development part was about 3 years and the implementation was 7 to 10 years.

Perhaps in a national problem other than in defense, I would say that the 2 years or more for systems concept definition is reasonable, a program definition of 1 year or less is reasonable. As far as development is concerned, it may be that 3 years would be a reasonable number for a pilot establishment or a test case. If that were successful, then it could be applied to other systems as well, other areas of the States as well.

Senator NELSON. Is that the production phase, the 7 or more years, which contemplates the problem of producing the equipment to implement the program?

Mr. DENNIS. Yes. In the case of the airlift, this is the development of the airplane, and then there is the production of the airplane and its actual use over its lifetime.

Senator NELSON. So if you had the equipment you wanted, if you had the airplane, you would be knocking off 10 years?

Mr. DENNIS. That is right.

Senator NELSON. That is, if you had the ideal aircraft at the time you started, and when you came to your conclusion if you had it on hand, the ideal aircraft, you would save 10 years on the whole operation?

Mr. DENNIS. You would not go beyond the point of system program definition. One thing that might be analyzed is whether or not the existing aircraft is satisfactory for another 10 years or whether a new aircraft is required.

As far as costs are concerned, these are just gross estimates, but they might be of interest to you. For every dollar that is spent in the systems concept definition phase, in the Defense Establishment, about $10 is spent during the program definition phase. In the development, it is about $100, and in the production and operation is about $1,000.

We have talked a bit as to whether these numbers are realistic when we look at other types of problems than defense, and I think they probably will hold up in rough orders of magnitude fairly well.

The low expenditures are in the systems definition and the program definition. Before a decision is made to implement and spend large quantities of money, at this point in time the total cost which is going to be accrued by system implementation, and its schedule will be well known and at this point in the defense business a contractor will go under a contract.

Senator NELSON. Just for purposes of the record, if this concept, this system, were to be applied to a social problem, of course, whether or not there would be that 7- or 10-year period, whatever, would depend upon the nature of the problem. You may not have to develop any equipment at all, but we would just change the system.

Mr. DENNIS. If we take the Mississippi water pollution problem that we were talking about at recess, it may take 7 to 10 years to put it in completely. In that case, it is an implementation and not a production problem, really.

We thought it might be of interest to you as to who accomplishes these steps in the Defense Establishment. I have broken down the three steps again: In systems concept definition, here the Department of Defense, allied analysis and evaluation organization, with supporting studies and technical data from industry; in the program definition phase, individual corporations or industry teams with governmental management agency supervision; and in the system implementation phase, the armed services departments and industry through program management offices.

I think it is interesting here to point out that in the systems concept definition, industry plays a relatively minor part in the first phase.

Senator NELSON. Your systems concept definition includes that part of the phase of understanding the problem?

Mr. DENNIS. That is correct.

Here the knowledge that exists in the Department of Defense and, let me say, the nonprofit type organizations and academic institutions, far exceeds that which we have in industry. When you are trying to understand the total problem, there are disciplines and knowledge which the industry does not have. So generally these types of organizations make the contribution to the systems concept definition.

There is a second reason for minimizing the role of industry here, and that is to get an objective solution to the problem. If industry came up with the concept definitions and later on had to implement

them, it may be that looking downstream they may feel that they could put their own system in that wasn't the preferred solution in a subsequent step. So one of the advantages to minimizing industry's role here is that they don't grade their own papers, they don't come up with a preferred solution and then implement it. That gives an objective analysis of the problem.

Mr. WHEELER. In our example, perhaps we can clarify the responsibility relationship of these people.

If you recall, at the beginning we had some six studies. The general policy study was conducted in-house at the DOD management level. The general analyses of comparing systems and general analyses of what are capabilities of airlift systems were done by analytical and evaluation organizations within the Department of Defense assisted by not-for-profit companies, and using information supplied by the industry as to what is the state of the art and what is practical and feasible.

Then the detailed studies on actual airlift systems concepts were managed and directed by the Air Force through its agencies and with a very direct interchange of information from the industry as to what is technically possible and from the industry as to what systems will be envisioned in solving the problem.

As was mentioned, however, this is of an informational nature.

It is also valuable to have the industry critique approach of Government, in terms of whether this is a practical thing and should it be instituted. The emphasis in the first step is rather heavily in the Government sector.

In the second step, the emphasis is in the Air Force management agency with industry participation, and in the third step of actually implementing the system, systems management by a contractor as directed by an agency of the Air Force.

So this relationship gradually shifts in terms of the amount of effort applied to the problem from in-house Department of Defense analyses through to more and more participation by the industry until, in systems implementation, the bulk of the work is now being performed and the bulk of the systems management responsibility performed by the industrial teams.

Mr. DENNIS. We have also indicated how these industrial teams are selected. In the systems concept definition phase, the selection is based on a request for proposals where the contractors describe their experience, their personnel and preliminary approach.

For the program definition phase, again it is based upon a request for proposals and the contractors describe their procedures, technical developments, and capability to undertake systems implementation.

In the third step, system implementation, it is based on the results of the program definition phase, particularly significant technical features and cost effectiveness of the total system being included.

I would like to point out two things here: Very often contractors will be asked to participate in systems concept definition where they might have a unique technical solution but where they are not qualified to carry the program on further.

This is the contribution through the whole process where industry assists in a systems concept definition. For example, in a water pollution problem it may be that a small company has a filter that might be

a key to the solution of the problem, but the small company cannot take on the total program management to clean up a major polluted area. He will be asked to participate in the concept definition simply to evaluate his filter.

The second point is in the program definition the contractor expresses his technical developments and capability. Recognizing that the system implementation is the phase where the contractor wants to participate, this is the end goal of the whole process, the implementation phase. Recognizing that the program definition phase is the necessary step to get to here, the competitive nature of the defense business has forced the industry to anticipate upstream the system implementation contract to the point where they begin to invest their own money in research and development in coming up with new solutions and new ideas so that during this phase they can get a competitive edge for the system implementation phase.

There has been a great deal of discussion on the application of aerospace technology to some of these other national problems and how to involve the aerospace technology. My feeling is that if this process is followed on these other national problems, and understanding that there are system implementation contracts in the future, in anticipation of these contracts the aerospace industry will start to direct their technical capability toward unique solutions to problems so they will be more competitive for the final phase. This is a way that this technology can bridge the gap from defense to these other national problems.

Mr. WHEELER. In the example, returning to the selection process, Mr. Dennis was mentioning that, in our model, 10 industries in the early phases felt they had significant technical contributions to make to this tactical airlift system problem.

Four of these in the Government's opinion had sufficient ability to make a material contribution to that evaluation process. By the time a system was actually defined, there were then only a limited number of industrial firms, five in this case, who had the preceding work, the background and the ability to go ahead and produce the system.

The number of people involved, the number of competing companies, narrowed, if you will, in a rather natural process, based upon their own assessment of their situation, their ability to proceed with the program, their ability to respond to the requirements of the Government.

From the five contractors, then, two were selected so that the Government would have two different points of view in their information, and two different approaches to a system implementation program, and two differing types of capability in actually producing the system. It was felt necessary in this system to have at least two companies in the program definition phase so the Government has the fullest amount of information about companies who are qualified to actually go ahead and produce the system.

The selection in each case is basically, in our model here, by the Air Force management agency, with the review and concurrence of the Department of Defense.

The basic responsibility rests with the Air Force to determine the capabilities of the contractors and their contributions to the program.

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Mr. DENNIS. We also indicated how these steps are funded. In the systems concept definition phase, Department of Defense operating budgets, contractural arrangements with support organizations and small study contracts with industry.

For the program definition phase, generally the contracts are with industry on a fixed price basis.

For the system implementation phase, the contracts are with industry having varying degrees of profit incentives, depending on the risks involved.

As I pointed out earlier, the ratios here are where this is $1, the next is $10, and the third step can run from $100 to $1,000.

Mr. WHEELER. In our example the cost ratios that Mr. Dennis described were generally borne out. I find them quite interesting. Our industry would not be aware of the cost of inhouse system studies at the very beginning of the program, because those studies are initiated inhouse in the Defense Department. However, some $10 million worth of systems definition contracts were let in the first step, followed by some $50 million of program definition contracts. We didn't quite go from 10 to 100, but we are in the same general neighborhood.

Then in this example, the development program of some $700 million and the actual implementation and production program something greater than $2 billion.

In this example, it was apparent to the Government that it was appropriate to proceed with contracting for both development and production at the same time, or contracted at the same time, I should say. So the first several years of production and the development preceding it were all contracted for at the beginning of this system implementation phase.

On examination of other examples one might find that the Government would elect to go ahead with the development program and reserve decision as to final implementation of the program.

Mr. DENNIS. This is the final chart, and it is a kind of summary to pull all the factors that we have talked about together.

Again there are the three steps: Concept definition, which utilizes systems analysis techniques, which provides alternative approaches to satisfy a requirement, the relative effectiveness of each, and probable extent of Government obligations.

The second step is program definition, which utilizes systems engineering techniques. It provides a preferred systems designs with alternatives, the cost effectiveness of each, and firm plans and schedules for design and development.

The third and last step is program implementation, utilizing systems management techniques. It provides plans and costs for orderly system development, production, and operation. It provides the timing and nature of the obligations, and assurance of cost and program control.

This kind of ties up the three steps and the techniques involved.

Senator NELSON. Thank you very much, gentlemen.

I think that anyone who had the opportunity to listen to the presentation in detail would understand the system approach that was used here. What troubles me a little bit is that most people who will

be considering this problem in the Congress will not have heard this presentation in detail and I think it will be a little difficult for them.

I say this only by way of asking you, Karl, this question. As I recall, in the California contracts there were four of them, one being crime and delinquency, one pollution, one transportation, and one information handling.

Would it be possible to take the pollution one, which I think was the smallest—though this is very fine in the record for anyone who wants to take the time and look at the charts in the record, and they can understand that after examining it—I was wondering if it would not be possible for whichever one of the corporations—and I think it was Aerojet that did the pollution study—to take that study and do a narrative presentation.

The report, itself, is too big, detailed, too fat to go into the record. But if one of the persons who worked on that could take it so that we could submit it into the record ahead of or behind this one, it would be helpful. It would be a narrative explanation, so that the general public could understand the concept, such as you would find in a magazine, for example. Would that be possible?

Mr. HARR. Dr. Roberts is here.

Mr. ROBERTS. When you ask if it is possible, Mr. Chairman, the answer is "Yes," it is possible.

Mr. HARR. I am sure we can do that, Mr. Chairman, and will.

Senator NELSON. Maybe if we ask someone who knows too much about the subject, they can never get it simple enough for the rest of us to understand. But I have read the report, and I think you could write a narrative explanation, it seems to me, of the pollution systems analysis report that was made in California. Don't you think so?

Mr. ROBERTS. We will be glad to, sir.

Senator NELSON. I think it would be very helpful. Anyone listening to this fine presentation in detail would understand it. But I think we need a simple narrative explanation. The only reason I suggested pollution is because it is one of the social problems which now has a high-level visibility and interest throughout the country.

Mr. HARR. We will certainly be glad to do that, Mr. Chairman. My only hesitancy, and I am sure it is unnecessary, is that one of the purposes of this rather full-blown examination in depth of a hybrid model study was to go beyond the phase involved in the California contract and studies and show to what depth there is an interface, a working together, and sharing of responsibilities, throughout all the way to implementation.

Senator NELSON. I think it is excellent. But there is this one other problem. If the committee finally reports a bill, it then goes to the floor of the House and the floor of the Senate. Everybody is very busy and there will be three or four people in each House who have read the hearings in detail.

Somebody is going to say, "Give me a good example." We can say, "There is a very fine example right here."

But if you can give a narrative example on a social problem, I think it would be helpful in explaining to Members of Congress what we are talking about. I think most people have not interested themselves in the idea of systems analysis and they will say, "Well, what is it?"

A simple narrative explanation will help the record for the presentation to other Members of Congress.

Mr. HARR. It will be done.

Senator NELSON. I want to thank you very much. It has been an excellent presentation, and it is very valuable for the record. I appreciate your taking this time.

Mr. HARR. Thank you, Mr. Chairman.

Senator NELSON. Our next witness is Dr. E. R. Roberts, vice president, Aerojet-General Corp., El Monte, Calif.

STATEMENT OF E. R. ROBERTS, VICE PRESIDENT (DEVELOPMENT), AEROJET-GENERAL CORP., EL MONTE, CALIF.

Mr. ROBERTS. Thank you, Mr. Chairman. It is a pleasure, indeed, to testify before you on a subject which we consider to be very important.

Mr. Chairman, the gentlemen who have preceded me today have very aptly pointed out what the systems approach is and how it is used in solving problems associated with the design, development, implementation, and management of complex defense and space programs. There are, however, some fundamental differences between these problems and those of a social or socioeconomic nature. Therefore, a review of our experiences in this field might be appropriate.

This is the third time that our company has had the opportunity of addressing you. In 1965 Dr. Culver, manager of our life sciences division, discussed the findings of our waste management study, and Mr. Lehan and Mr. Kuhn presented the results of our crime and delinquency study. Since then we have become engaged in two more studies of similar nature.

Today, with your permission, I would like to review our total experience from the standpoint of—

(*a*) To what degree our talents and our methodology is translatable to solve socioeconomic problems.

(*b*) What kind of difficulties we have experienced.

(*c*) What contribution to the solution of these problems can be expected from the aerospace industry.

And finally, to what time schedules could we perform?

Let me start with the translatibility of our talents and methodology.

We found that in all cases we studied, the system enigneer had no unusual difficulty understanding the problem, and with the help of systems analysts, statistician, computer scientists, and consulting experts from the particular socioeconomic field, he was capable of putting the methodology fully to use.

Indeed, Mr. Chairman, in all cases he could construct a system framework within which the problem could be logically attacked. I wish to emphasize that we had to construct a system framework, because as yet the various operations, which must contribute to the solution of the problem within a so-called socioeconomic system, do not operate in unison to accomplish a defined objective. Indeed, if we accept the simple definition of the system—that it is a set of operations designed to perform a specified objective—we must say we have very few, if any, socioeconomic systems operating today. We do have a number of socioeconomic problems, which may have grown to the proportion in which they exist today, exactly because of the lack of such systems.

With that thought in mind, it is of significance that we have been able to cast these problems into a system framework. We have shown in previous presentations to you block diagrams representing such systems framework for the criminal justice and the waste management systems. I have no intention of discussing these systems in any detail today. But I would like to take a few minutes, running the danger of being repetitious, to give some specific examples from each of the studies we performed to date to show that the systems methodology gave us, indeed, a better insight into the problem.

For example, in the crime study, we introduced the concept of the so-called career cost of the criminal, which is the cost to the State of any criminal during his criminal career. The data indicated that the most costly criminal is a check forger, which is a rather unexpected finding.

We have succeeded in our social welfare study to quantify the characteristics and magnitude of that part of the population which is most likely to be a welfare recipient.

In our waste administration study, as you recall, we have found ample evidence that all types of waste, whether it is solid, liquid, or gaseous, must be dealt with together as a part of one system.

These findings and the several others which we prevented in our report, per se, do not solve the problems, but they give us a much better insight and permit us better planning while we are seeking solutions to these problems.

Now, let us take a look at the difficulties we encountered. In all the studies we undertook to date, Mr. Chairman, we ran into two major obstacles. Both may stem from the previously mentioned lack of existence of truly planned socioeconomic systems. These two obstacles are:

(*a*) The uncertain nature of goals and objectives.

(*b*) The lack of necessary data to find cause and effect relationships.

While we strongly believe that these are only temporary obstacles since systems analysis is particularly suited to solve this kind of problem, nevertheless, they do exist today, and it is important to fully understand their significance. To shed better light on this area, let me refer for the moment to a typical military weapon system development. The Government (frequently with the help of nonprofit organizations) sets specific goals for the system. The industry evaluates various possible concepts, elects the one which offers the best solution, sets performance requirements on all the subsystems, and then perhaps hundreds or thousands of companies go to work to reduce the concept to hardware. If, in the course of development, problems arise—and they always do—the quantitative impact of the problem upon the total system is evaluated, and if the problem persists, an alternate route might be explored. Important is the fact that the problem can always be assessed quantitatively in terms as it affects the total system performance. In contrast to this, the socioeconomic "systems" have evolved without the setting of firmly defined goals. The problems with which they have to deal exist against a backdrop of social, political, legal, and economic influences.

Since the socioeconomic systems today have no quantitatively established objectives, the magnitude of the problems they face cannot be measured in terms of system performance. Thus, a logical solution to the problem is obstructed until we remove this obstacle.

Further, in order to come up with solutions, at least reasonable understanding of cause and effect relationship between the more significant contributing factors must be developed. This is particularly important since solutions to socioeconomic problems must evolve from the present environment. This environment, regardless of how bad it may be, cannot be swept away like an obsolete weapon system when it is replaced by a more modern one.

Thus, in attacking a socioeconomic problem, without the knowledge of why things are the way they are, we are starting not from point zero, but we start from a negative position. This is not an unusual situation. I well remember, Mr. Chairman, that 20 years ago, we were in a similar situation in the rocket industry. We had difficulty writing good specifications, because we did not know what could be accomplished. We had difficulties of solving problems, because we had no good knowledge of cause and effect relationship. So most of the rockets just blew up. We had to analyze, correlate, hypothesize, experiment, and evaluate, and reiterate the process again and again in order to arrive to point zero, in order to advance to the point where reasonable goals could be established and systems capable of coping with problems could be evaluated and developed. We are today in a similar position in many of the socioeconomic fields, with the exception that we now have a proven methodology and a substantially advanced technology at our disposal.

Senator NELSON. May I interrupt you a moment?

The fact that you couldn't come up with a final answer to some social problem still wouldn't mean, would it, that the methodology could not help you come up with some answers and thus would be of great value anyway?

Mr. ROBERTS. Certainly.

Senator NELSON. As a matter of fact, I would guess that in a fair percentage of the most pressing social problems you will not have all the answers because in most of them there are human factors involved that we don't have a capacity to evaluate anyway.

This is true of the use of pesticides in this country. We are seeing consequences from their use that are causing ecological imbalances in the seas, in the lakes, in the soil, in the whole environment that couldn't be predicted. But that doesn't mean that you couldn't tackle the pollution problem, including pesticides, and come up with an answer that improves the situation vastly. That is what I am getting at.

Mr. ROBERTS. That is correct. The fact that you don't know ultimately what you want simply makes it very difficult to come up with the best solution to the problem. It doesn't make it impossible to come up with improvements, and with systems methodology we can introduce improvements without having that ultimate goal.

What I would like to stress is that this system analysis would permit us to set very intelligent standards which today are lacking.

With this in mind, let us take a look at what the aerospace industry can contribute and on what time schedule the accomplishments can be realized.

Since each system is beset with different kinds of problems and our contributions may vary vastly from one to the other, it may be more meaningful to take the crime study and waste management study

as specific examples rather than talk in generalities. These systems happen to be typical of two kinds of systems: No. 1, the crime study deals mainly with software; that is, the generation handling, and dissemination of information, and No. 2, the waste management system has primarily a hardware orientation.

In the area of crime and delinquency, we believe there are activities which we can profitably undertake immediately. For example, substantial benefits could be derived by improving the information flow within the system and assure the availability of maximum meaningful data at the decision points in the system. Further, we could improve the system to effect a faster processing of the criminals. In undertaking this effort, which would take from 3 to 5 years, we are dealing primarily with methods of handling the problem, rather than with the problem itself. More germane would be our contribution to the solution of the problem, Mr. Chairman, by designing, with the help of social scientists, behavioral scientists, penalogists, psychologists, psychiatrists, and so forth, well designed and monitored statistically significant sociological experiments to yield data which would permit us to verify or reject hypotheses previously made. The very nature of this iterative process and the long leadtime required for feedback takes at least 5 to 15 years before meaningful data can be expected.

On the basis of the data resulting from such experiments, we might be enabled to intelligently use our resources to cause the basic problem to recede. Finally, as far as the criminal problem is concerned, we can contribute to pinpoint areas of basic research and help to evaluate data obtained in the course of the research. This activity would be directed to understand what makes a human become a criminal and would have to go on, like cancer research, until the problem is totally resolved.

In the waste management area, our immediate contribution should be directed to establish useful environmental quality standards. We believe that within 3 years, through a program of basic research, involving environmental sciences and system analysis techniques, we could fix useful quality standards for air, water, and land. Further, we believe that within 5 years we could design concepts capable of meeting these standards. Paralleling this effort, within 10 years, these concepts could be reduced to hardware, and in 15 years, we could start the implementation of the system and really solve the problem of pollution. We are fully aware of the fact that no socioeconomic system can be implemented in a vacuum, and we must take utmost care to avoid or at least minimize adverse effect on interfacing systems of our society.

Having presented evidence that the systems methodology and our talents are translatable to socioeconomic programs, and having discussed the problems encountered in the past and our potential contribution in the future, let us examine what the roles of government, educational institutions, and industry should be to permit an effective attack on these problems.

First of all, we do not believe that any new institutions are required. A better definition or realinement of responsibilities of existing institutions is, however, desirable to facilitate their capability to handle programs on a "systems" basis.

Most of our socioeconomic problems, such as pollution, for example, do not have the arbitrary boundaries of political entities, such as States and municipalities. Consequently, the Federal Government would have to play, in this case, a significant role in establishing nationwide guidelines. Further, the Federal Government should stimulate research and development pertaining to countrywide problems.

Complementing this activity, the State and local governments should have the responsibility to undertake research and development pertaining to local problems and have the responsibility of implementing the required solutions. As far as the universities are concerned in this endeavor, we believe that they should be continued to be supported with grants to undertake research with the traditional freedom characteristic to such institutions, recognizing the fact that such research might be fragmented. The pinpointed effort to solve complex system problems on specific time schedules must be assigned to industry.

In summary, we believe that we have today more than just conjecture, but actual evidence that we, indeed, can use our methodology and technology in our endeavor to solve socioeconomic problems.

As a result of our participation in the various studies, we have gained a better insight into these problems, and we can, indeed, identify areas where an immediate attack on the problem appears, at least to us, to be logical. We can identify problem areas where a relatively short-term solution could be expected. I believe 5 to 15 years is a relatively short term when you are looking at problems of this nature.

But the latent capability of our industry to deal with these problems, we believe, is not enough in itself. We need much more. We need a very close cooperation with Government institutions; we need a very realistic assignment of funds and time to exploit this capability to the best interests of our society.

Thank you very much for your attention, sir.

Senator NELSON. Thank you.

The Congress some few years ago made grants available to States and municipalities for purposes of comprehensive planning, State planning, regional planning within a State of several counties, and so forth.

In many States, city, as well as regional planning commissions, have been developed, especially in the past 6 or 7 years, and have been accelerated as time goes by. Would you not agree that in terms of tackling quite a few social problems, comprehensive plans have to be developed by the regions, by the local areas, by the cities, by the States, in order to provide the detailed information so that you can apply the systems analysis concept?

Mr. ROBERTS. I would like to state a little in reverse. First, I feel the Federal Government has to give a guideline of what has to be accomplished, and then the local areas can come up with the detailed plan which would fit into the overall guidelines. But there must be a general, uniform guideline. Otherwise, we might find that the various regions are coming up with conflicting interfaces when they meet at one point of the geographical map.

Mr. Chairman, today in California we are actively engaged in a Solid Waste Management Study for the State of California for the Fresno area. This study is funded by a grant from the Federal Government.

Senator NELSON. I believe that legislation was passed about a year ago.

Mr. ROBERTS. Yes, sir.

Senator NELSON. I thank you very much for your very fine presentation.

Mr. ROBERTS. You are welcome.

Senator NELSON. That will conclude the hearing for today. We will resume in the morning at 9:30.

Thank you all very much.

(Whereupon, at 12:08 p.m., the subcommittee recessed, to reconvene at 9:30 a.m., Wednesday, January 25, 1967.)

SCIENTIFIC MANPOWER UTILIZATION, 1967

WEDNESDAY, JANUARY 25, 1967

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON SCIENTIFIC
MANPOWER UTILIZATION OF THE
COMMITTEE ON LABOR AND PUBLIC WELFARE,
Washington, D.C.

The special subcommittee met at 9:30 a.m., pursuant to recess, in room 4232, Senate Office Building, Senator Gaylord Nelson (chairman of the special subcommittee) presiding.

Present: Senator Nelson (presiding).

Committee staff members present: William Spring, special counsel to the subcommittee.

Senator NELSON. We will continue hearings today on S. 430, the Scientific Manpower Utilization Act of 1967, and S. 467, the National Commission on Public Management.

This morning we will have testimony from Senator Hugh Scott of Pennsylvania; Dr. Simon Ramo, vice chairman of the board, TRW, Inc.; and Dr. Robert Lekachman, chairman, Department of Economics, State University of New York.

Mr. Kurt Bauer, executive director, Southeast Wisconsin Regional Planning Commission, was unable to get a plane out of Milwaukee because of weather, so he will not be here this morning.

We are very pleased to welcome the distinguished U.S. Senator from Pennsylvania, Hugh Scott, who is the author of S. 467, the National Commission on Public Management.

We are pleased to have you here this morning, Senator Scott.

STATEMENT OF HON. HUGH SCOTT, A U.S. SENATOR FROM THE STATE OF PENNSYLVANIA

Senator SCOTT. Thank you very much, Mr. Chairman. I am very happy to be here and have the opportunity to discuss the approach embodied in S. 467.

In the current issue of U.S. News & World Report, there is an article on the future, and there is a line in that article which says that the dreams often have a way of coming true. The point is made that in this past short decade alone, advances have occurred which greatly affect the present and will more greatly affect the future of all our citizens.

The point is made that 10 years ago there were no jet commercial aircraft and virtually no activity in space, and that the use of computer systems was just beginning.

Projections are made for the years 1970, 1980, 1990, 2000, with some fascinating prospects held forth for a long and better life in forthcoming eras. I believe the article ends with the statement that we were born too soon. The best is yet to come.

It is in line with forward thinking, then, that I introduced S. 467.

I appreciate this opportunity to appear before this subcommittee and discuss a matter of vital concern to all Americans.

Members of Congress have become increasingly aware that dynamic, innovative steps must be taken if this Nation is to continue its progress. The past decade has been a period of creative legislative action insofar as the establishment of policies and programs to solve our social and economic problems is concerned.

Significant achievements have been registered in pollution control, planned urban development and renewal, housing and education, public health, and the preservation of our natural resources.

I might note, parenthetically, that in his state of the Commonwealth address yesterday, the Governor of Pennsylvania, Raymond P. Shafer, has taken note of many of these demands and has made very progressive and challenging recommendations to the legislature in the fields of urban transportation, public welfare, pollution, public health, and many other fields.

I am glad to see that this Governor and, for that matter, most of our Governors, are becoming aware of the role of the States in this area. But it is the role of the Federal Government in partnership with local and State governments to which I address myself.

In spite of this record of significant achievements that I noted a moment ago, the responsible authorities at all levels of government—local, State, and National—face a host of serious problems caused by a society which is characterized by its increasing complexity, rapid rate of growth, and high mobility.

The magnitude of the problems leave no doubt that traditional solutions alone will not provide relief. The resources of all facets of this Nation must be marshaled to meet this challenge. This generation of Americans has lived through an era spanning the past 25 years that has brought numerous and deeply felt changes in our way of life. Atomic power, the space age, and various evolutionary changes in our defense capability have come about through the ingenuity, business acumen, and industry of all facets of society.

As the result of the endeavors of private industry, the universities, and governmental components, a great deal of useful knowledge and an appreciation for new equipments and procedures have accrued. We have seen new techniques of management analysis—often termed the "systems approach"—developed, tested, and incorporated into the mainstream of industrial activity.

While the systems approach most often is associated with the work performed by the Department of Defense, the Atomic Energy Commission, and the National Aeronautics and Space Administration, attention recently has been given to applying it to the problems in the public domain which I just enumerated.

Although the United States is a wealthy nation—indeed, the mightiest in the history of the earth—its resources are not unlimited. The decisionmakers of the Nation must assess carefully where and

how to expend these resources. No longer can we afford to expend 90 percent of all Federal research and development funds on defense, space, and nuclear energy developmental projects.

Not only must the Federal Government increase its expenditures to combat pollution, urban sprawl, and natural resources dissipation, but the State and local governments must do likewise.

What steps can be taken to achieve our ultimate goals? Two worthy efforts have been initiated within the Congress which can go far in helping to resolve the national and community problems in the nondefense, nonspace sector. You, Mr. Chairman, proposed a bill in October 1965, reintroduced as S. 430 last week, which delineates a course of action in precise terms: To mobilize and utilize the scientific and engineering manpower of the Nation to employ systems analysis and systems engineering to help to fully employ the Nation's manpower resources to solve national problems.

A series of hearings were held last year which have been most useful in obtaining factual data and commentary from experienced participants in using the systems approach in various applications areas.

A concurrent approach, which I believe to be complementary both in concept and ultimate ramifications, was introduced last August which called for the establishment of a National Commission on Public Management. I had the honor to introduce this measure, which was cosponsored by nine other Senators; a companion bill was introduced in the House of Representatives by the Honorable F. Bradford Morse of Massachusetts and more than 40 of his colleagues.

With the convening of the 90th Congress, these bills were reintroduced by Representative Morse (H.R. 20); and myself (S. 467) with the same strong support.

The mandate of the Commission, as I stated in my introductory speech on the floor of the Senate on January 18, will be to answer two fundamental questions: "Can the systems approach contribute to the solution of these problems? If so, how can it best do the job?"

The Commission, to be composed of 13 outstanding representatives from business, labor, education, and Government, would have a full-time staff. With a basic purpose of studying the ways in which modern systems analysis and management techniques may be utilized to overcome society's problems, the results would be in the form of specific recommendations for legislation, Federal executive action, and implementing action by State and local jurisdictions.

Senator NELSON. If I may interrupt, Congressman Bradford Morse was before the committee yesterday. I understood him to say that last year your bill had on that Commission, Members of Congress, and this year your bill in this House does not. Am I incorrect?

Senator SCOTT. I cannot speak with certainty about Congressman Morse's bill, but mine, both last year and now does not.

Senator NELSON. He called my attention to that, and was urging that Members of Congress be on the Commission. I understand his version does include Members of Congress. Is there a policy reason for not including Members of Congress?

Senator SCOTT. No, there is no policy reason, Mr. Chairman I would have no objection at all. Mr. Morse has told me of his willingness to accommodate me by combining the two approaches. I would,

in turn, have no objection whatever to considering the advisability of including—in fact I would react favorably toward including—a provision that members of the Commission either may or shall be Members of Congress, as seems best after I have a chance to talk with Mr. Morse.

Senator NELSON. I don't personally have an opinion on it. He seemed to have one, so I though I would call it to your attention.

Senator SCOTT. I appreciate that. We will consult with Representative Morse.

During the current set of hearings before this special subcommittee, emphasis has been placed upon learning more about the ways in which the systems approach, as developed in private industry, can be brought to bear on these pressing problems. I feel that the subcommittee is wisely inquiring into the role and relationships of the many participating elements in this complex environment: the State, local, and regional governmental groups, the universities and colleges, the "think-type" institutions—both profit and not for profit—and the Federal Government.

I did not mean the last statement to be wholly exclusionary; I would not exclude the Federal Government from the category of "think-type" institutions, although I would like to give that some consideration, also.

Many tools and techniques, including the electronic computer, have been developed and applied to the spectrum of domestic problems. In a few instances, as in the State of California, where specific subject studies were undertaken by selected aerospace firms, valuable data concerning the nature of the problem and possible mechanisms for solution were obtained.

It is my firm belief that before steps are taken to allocate funds to various States, we need to know more about which management techniques can be really effective in coping with the complex problems which were earlier identified.

Forecasting the future is a responsibility to be shared by all of us in the policymaking role. The problems are multidimensional and will be solved only by the joint efforts of the private and public sectors. I was particularly impressed by your call to action, Mr. Chairman, when you stressed:

> Nothing short of a massive effort by industry and government at every level will solve this problem. This can be done only after a total analysis of the problem and development of an overall program of action.

The Congress has evinced willingness to confront the issues of the day, and to pose solutions. Technology is now available which will allow us to purify our streams, cleanse the air we breathe, construct good housing at a fair price, and provide health care for every citizen. The men and women of America have had to comprehend and assimilate new techniques for producing the everyday necessities, engaging in recreation, and communicating with their neighbors. Forward progress is not always smooth and some turmoil and adjustment is involved in almost all technological change. But our record for meeting these challenges in this country is very good.

In summary, I commend this subcommittee as it moves forward to provide a better way of life for this generation and generations to come. It will be the responsibility of the Congress to take those steps necessary to provide the forces of our society with the guidance and resources to establish a reasonable course of action.

The problems are complex, and the myriad possibilities for resolving some of them equally complex. To my way of thinking, the time for decision and action is now. The future of this Nation depends upon our foresight and forcefulness in this, as in many other areas of new challenges.

I want to thank the chairman for his consideration in arranging for me to testify at this time.

Senator NELSON. I appreciate your appearance before the subcommittee today.

As you know, Senator Dominick, who cosponsored your measure, is a member of the Labor and Welfare Committee and had intended to be sitting on these subcommittee hearings, but there are some very important hearings on the supplemental Vietnam budget which demanded his attention.

I have talked with him about working out or attempting to work out a bipartisan bill that incorporates the concept in your bill, and the concept in the one I introduced. I think all of us agree that search as hard as you might, you can't find a partisan issue in this bill. It is a matter of equal concern to all people, regardless of party.

I find, in talking with my friends who are systems engineers, that one of the problems that seems to puzzle them the most, and which is difficult but wouldn't puzzle you as much, is the implementation of the program once you have done the analysis of the problem. They have been accustomed to dealing, for example, with DOD. Once they accumulate the facts, identify the problem and evaluate alternative methods of solving the problem, immediately when the decision is made, DOD goes ahead and does it.

The difference in applying it to a social problem is when you get to the decisionmaking stage, it isn't just a question of DOD and the systems engineering group to say, "We will now take this money that has been appropriated and spend it." When you get to the social side, then it has to go to the city councils, the county boards, the regional planning commissions, and the Congress of the United States.

The political decision to implement a program which has been evaluated and alternative solutions proposed is a political decision. They, I think, found it difficult to visualize how that would work. I don't think it is quite so difficult as they do.

I know it raises tough political questions, but I am satisfied that once you get an evaluation which came up with a constructive solution of the air pollution problem, the political leadership of this country will have the capacity to implement it because the public demand is there and will be there.

Senator SCOTT. I would think so, Mr. Chairman. I don't think there is any politics in crystal balls here or in peering into the future. The application of these techniques to social problems involves these elements that you mentioned, and involves also the interaction on human beings.

The Department of Defense, of course, can decree methods toward solution. That somewhat more arbitrary technique is not quite as applicable when you get to social problems. The political and social difficulties are certainly not insurmountable, but the approach, to my

mind, is essential if we are going to do our best to manage the future in keeping with the concepts which guide this country's way of government and way of life.

We, in my office, would be very glad to help and would be very happy to be associated with some combined and common effort by yourself, Senator Dominick, and any others of like mind if we can be useful in that area.

Senator NELSON. I certainly will want to work with you.

I want to make one more observation: There is, in fact, quite a bit of systems engineering, systems analysis technique, being used in the social field already in this country by our many regional planning commissions. One of the early ones was Dade County in Florida.

While I was Governor, we created the southeast regional planning commission, which involved seven of the largest and most populous counties in our State and also the Wolf River Planning Commission. Each one of those commissions is deeply involved in the technique we are talking about and very successfully so.

That is why I particularly wanted Mr. Kurt Bauer to be present, but he is unable to be here today.

I think the record will show that there are many places in this country where the very techniques we are talking about are presently being applied to the solution of social problems. The Southeast Regional Planning Commission of Wisconsin is developing a comprehensive transportation plan and recreational plan, and several other plans, using the very techniques that we are discussing here.

So I don't think there is any question about the feasibility of applying the technique to social problems. It will vary in its feasibility. Air and water pollution may be a whole lot simpler one to tackle, say, than some of the social problems that involve a more direct human element.

Senator SCOTT. I think it is quite interesting that Governor Shafer, in his state of the Commonwealth message yesterday, concludes the message with certain recommendations, the last of which is:

> Adoption of a new Pennsylvania Municipalities Planning Code to help our communities plan better for the growth that is coming.

I am a member of the Pennsylvania State Planning Board, along with my senior colleague, Senator Clark. My legislative assistant, Mr. Richard W. Murphy, who sits with me this morning, attends its sessions whenever I am unable to be present. We have a continuing interest in these problems and the relationship between the Federal Government and our Commonwealth.

Senator NELSON. Thank you very much, Senator Scott. I appreciate your taking the time to appear before us.

Senator SCOTT. Thank you, Mr. Chairman.

Senator NELSON. Our next witness is Dr. Simon Ramo, vice chairman of the board, TRW, Inc., of Cleveland, Ohio.

STATEMENT OF DR. SIMON RAMO, VICE CHAIRMAN OF THE BOARD, TRW, INC., CLEVELAND, OHIO

Dr. RAMO. Senator, I am very happy to be here. I have no written or prepared statement. I have prepared myself to make extemporaneous remarks and provide answers to your questions. In preparation

for this day, I have read all of the testimony and I have been informed as to the testimony of the last day.

Senator NELSON. Would you identify your company and some of your background for the record, Doctor?

Dr. RAMO. Yes. TRW is a large, diversified corporation, at a sales level of about $1 billion. Some hundreds of millions of dollars of that is made up of work for defense, either directly or indirectly, or for space.

Senator NELSON. What does TRW stand for?

Dr. RAMO. Formerly, Thompson Ramo Woodridge: the official name of the company, the legal name is now TRW, Inc.

A considerable fraction of our work is for the Federal or other agencies of Government, about one-third. Within that there is a very large segment that is involved in systems engineering, including some several millions of dollars on what might be called the social system engineering type of effort with which this subcommittee is concerned.

Senator NELSON. This is on a contracting basis?

Dr. RAMO. Yes. Some of it is being done through our own funds as initial studies, preliminary toward contractual work with agencies of the Government.

Senator NELSON. I don't want to, from here, direct the course of your presentation. Would you prefer to go ahead and make your extemporaneous remarks?

I was going to ask you to identify some of the systems engineering work that you have done in the social field. I will assume you will do that.

Dr. RAMO. I will be happy to do that.

May I first comment on the fact that a good deal of what I would have felt desirable to write out in an effort to be helpful to the subcommittee has been, I think, exceedingly well done in previous testimony. In fact, I might add that what has been brought out here publicly in these hearings, I think, is very impressive in providing what might be called a textbook on what systems engineering is, and how it might be applied.

I think some, clearly not all, of what the bill to create a National Commission on Public Management seeks to accomplish is being accomplished through these hearings.

You have brought out that systems engineering or systems analysis is not magic, it is not new, but that, indeed, particularly over the last decade or two, that methodology has been developed to a very high degree of competence and applicability, and that it indeed is broadly applicable to the social engineering problems.

TRW, as I indicated, is very active in systems engineering and more recently active in what I might call social systems engineering projects. It may be that we have the largest team of systems engineers in industry. We have in work now some 8 or 10 projects that are in the fields of health, transportation, information systems, land use, and other such social problems.

It might be helpful for me to take one or two examples and make some comments about those prior to your asking some questions, if it seems suitable to you.

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I have chosen these examples under the heading of "Implementation." I have chosen them particularly in the last moment or two in hearing your remarks of a few moments ago.

It appears very well established by the previous testimony that systems engineering is applicable to major public or social problems. I consider myself basically a systems engineer although I have been an executive for the last several years. I think we all tend to see systems engineering as a natural quantitative analysis, quantitative commonsense, as it has been called by some witnesses here, and of considerable applicability, to problems such as those to which S. 430 and S. 467 are addressed.

But we are not skilled on the political side. Naturally, we have interfaced with the political side for many years, but we don't consider this our area of maximum expertise. Therefore, the implementation of systems engineering, as you brought out a few moments ago, is most important, but seems to some of us rather difficult in those problem areas by comparison with the application of systems engineering in, let us say, defense areas.

Two examples come to mind, one has not yet started officially under contract, but that we hope might be started fairly soon with us or some other organization.

One is a project of the Los Angeles Police Department. Here you have a more or less single entity in government with leadership that recognizes a problem. It has occurred to them that to handle the increasing problems of that police department, they have some choices, and those choices include spending available funds in part to augment the police force under, shall we say, conventional concepts, or to improve communications, information handling, command and control in such a way as to make the manpower much more effective by being in a better position to use their resources at any given time.

It has also been apparent to this leadership that if they are going to do this, they must have aid from those who are experienced in the analysis of the flow of information, and who know the latest technology in the handling of information, in the acquisition of it, in the storage of it, in the assembly and processing, and finally in the communicating and display of that so that it can be used for superior command and control of operations.

In this connection, we have naturally come together and we are studying that problem. But the implementation and attendant management relationships would appear there to be relatively straightforward. I think there is a lesson to be learned from this: That is, as our studies show the economic gain and the performance gain that can be obtained by the use of modern technology in reorganizing the handling of information, and command and control functions within the police department, the department would then request that part of the funds available for the police department, in effect, be allocated for the implementation, modification, and organization required; for the installation of equipment, the training in new procedures and, in general, for changing the man-machine interrelationship within the police department in order to attain this higher performance.

They would be able to see not only what it would cost, but what they could hope to gain from it. They will be in a position to explain and defend what the advantages will be.

I think it will be so convincing a case that it will be relatively easy for them to obtain the necessary sponsorship to make this happen. When they do that, I think it will be an example for other police departments throughout the Nation, and the process will grow quite naturally.

Senator NELSON. If you are going to another example, I would like to mention something.

What you have just said demonstrates that systems analysis can be applied in a limited, narrow scope, such as in the police force in Los Angeles, to improve their techniques of policing, so to speak. We do that in program budgeting in a limited fashion.

At the same time, if you are going to look at the problems of the police departments, you have to also, at some stage, do an analysis of what causes crime, what causes the juvenile delinquent.

I have noticed recently in talking with a principal of a high school in Milwaukee who has a Teachers Corps team of three teachers—and I don't want to stand on these statistics, but I will correct the record when it comes back to me—who had in this school 40 or 50 children who were quite a problem. They came from a particular part of the city, a very limited area. They were flunking two or three courses, or more, and they were disciplinary problems in the school.

This year when they had the Teacher Corps team, they took about 30 of those youths who were flunking three courses or more and assigned them to a Teacher Corps student on a one-to-one basis, and instead of sending them to the principal, they were sending them to the Teacher Corps teacher, to sit down and work with them on their problem in school.

Pretty soon a substantial percentage of them were passing all their courses, and another percentage were only flunking one course. Pretty soon the discipline problem disappeared.

This is all by way of saying that in dealing with the police side you can apply the technique to improving the management and the effectiveness of the handling of information and that sort of thing, but to get at the total problem, you have to get behind it and find out what caused the youth, for example, to get into trouble in the first place.

It is here where I think systems analysis can provide some very effective answers. You can keep spending money and become more and more efficient, but you still have more and more problems that you are dealing with because you are not getting at the social problem that would solve that problem.

This one in this school demonstrated a very simple example of suddenly getting rid of very difficult disciplinary problems, suddenly getting children who were getting special help becoming better students, cooperative and part of the useful social community in that school.

Dr. RAMO. I think your remarks, taken with mine, constitute an opportunity to emphasize a point which has not yet been emphasized in the hearings. Systems analysis conjures up in the minds of many people who are associated with it the concept of completeness, the concept of recognizing the tremendous amount of interaction between various pieces in any complex problem.

The experienced systems engineer expects this and arranges his work so as to give great attention to this interaction in optimizing or insuring a harmonious ensemble of all the pieces of the solution he

proposes. However, in parallel with this, and notwithstanding that major aspect of the value of systems engineering, it is important not to neglect what might be called that systems problem which is one level below. To the super-systems man it is a subsystem.

The Los Angeles Police Department, for example, will have a certain amount of funds that it can expect to have allocated to it to cover the salaries and the operations of the police department, to handle crime, which should and might be lower if the whole problem of crime were, over a period of years, properly subjected to adequate total systems analysis and study. But we know that some of it will remain.

The question can to some extent be separated: How can they make the best use of the salaried people, which takes up a good part of their total budget, by knowing where all the cars are, where all the policemen are? Or isn't that an advantage?

So we need to do both. First, we need to arrange that we encompass problems in their totality and bring in the methodology for doing this neatly and efficiently in the way that systems engineers have learned to handle. We also need, in parallel, to take some of the pieces, and even though they could be better done if the whole job were completed, we need to improve the pieces in order to get something done that is highly beneficial to society. Otherwise we are not doing a good systems application.

Perhaps the next example will bring out some more of this. We are heavily involved in the study and the design, and ultimately the implementation, of a new medical center in Alberta, Canada. This will be a $100 million complex. It involves university operations, it involves training, and it involves, of course, patient care.

The leadership there knew that they wanted to uplift the health of that entire region and they wanted to do this on both a short- and a long-range basis. They sensed that there was a great deal of interrelationship between preparing for the future on the one hand and handling the emergency of the moment.

They also sensed that they could not arrive at the best solution to their problem with their funds by, let's say, superior design of buildings alone. Problems such as the total amount of information moving about that $100 million complex, having the right information at the right place and at the right time, doing this sensibly and efficiently; and taking into account the interactions between information and patient care, between information and business operation, between information and training and education, were all factors which also had to be considered.

They also recognized they had a problem of logistics in handling material, the right amount of material, the proper amount of it stored and ready for use, the proper inventory control; and, of course, the movement of that material.

Then, of course, there are the people, those who are at work doing specific jobs as well as the people who are patients. The number of tasks to be performed and interrelationship amongst them were enormous in quantity.

They recognized the need, then, to put all these and other parameters on a logical, systematic basis, as has been discussed before this group.

My reason for choosing this example is not to use it as a further opportunity to elucidate on the principles of systems engineering, which has been adequately done, but rather to emphasize that here is a project that is being implemented. It is being implemented because, again as has been brought out this morning between you and Senator Scott, when the public adequately understands that it wants to do something serious about a particular problem area, and when the leadership to whom the implementation is allocated have an appreciation for what has happened in modern technology, and what has happened in methodology for handling, for properly assesssing and considering all of the diverse, complex parameters; then the step of implementing a solution seems much less difficult.

Senator NELSON. Are you, in your analysis of this $100 million medical setup, giving some consideration to a problem that the medical profession has never, so far as I know, addressed itself to very creatively. That is, some consideration to the problem of a comfortable environment for the patient who gets there?

I have observed the hospital environment sufficiently to conclude that you frequently cure the disease but you make a psychosomatic case out of the patient because of the coldness and sterileness of the environment within which you put him.

This is a problem which has been ignored in the construction of hospitals and treatment centers, the factor of the consideration of the feelings of the patient who is there.

Dr. RAMO. Senator, you have brought out something here which I think again enables a comment to be made which has perhaps not been brought out fully in previous testimony.

If you look at the systems engineering fraternity of this Nation, whether it be in industry, universities, government, or nonprofit institutions, I believe you will find that by and large it represents a considerable amount of competence useful in the social field, but it also has some shortcomings.

Specifically, TRW would not, despite its having a very large and experienced systems engineering organization, presume for a moment that we could, alone, go in and design this complex. Rather, we consider ourselves partners with those who have been practicing medicine for years, those who have been living with that side of the problem which includes the human being.

This is not to say that systems engineers are unaware of and have not experienced problems that involve the social as well as the economic, the psychological, and the political side. But there are always specifics in any problem that only a person who has been living with that particular specialized field would know adequately.

The first thing we have done, even in our proposals which lead to winning a competition, is to spend a great deal of time living and working with those who have been in the hospital areas, for example, and who have listed all the things they have found as problems, things they would like to see better in the future.

The problem you brought up has been an example. We would not do a good systems engineering job, which, of course, we hope to do, unless we included that class of problem, and, in effect, tried to arrange the entire system to do that.

I looked at one detail before I came here which I think demonstrates this. This is the queuing problem. Anyone who has been in the hospital and has been able to walk around to get his tests made is, I think, always annoyed by standing around with a semiopen gown waiting for his X-ray to be taken. If you list the tests that have to be made, covering a wide range of different kinds of medical cases, and you look at the way in which you make those tests, the apparatus to be used, the number of operators, the length of time it takes, what is to happen to the test results; you could find, if you don't quantitatively consider all of these factors of capacity, speed, timing, and interrelationship, that you will have arranged a hospital system in which a typical patient may, after he has his tests made, wait so long for the tests to come back out of the system to be acted upon that he will be long since gone.

Take another problem of less serious consequence: He will be waiting to long in the hall in line. So one of the things we are doing is analyzing all of the queuing lines, putting numbers on, and then coming back to the medical people and saying—

What kind of a waiting time do you consider to be satisfactory, desirable, an absolute lower or an upper limit above which it is too luxurious? You are experienced in the handling of patients.

All through the system we are looking at queuing lines, and we are doing it for efficiency reasons, one might say, the same as we would do if it were a piece of freight, or a package of medicine. But we are also doing it for human reasons.

Senator NELSON. I am glad you brought out this point. What I was really wanting to get at is I think most people have the impression that systems analysis involves just engineers, statisticians, and so forth, whereas the fact is that the team that you would use depends upon the problem you are attacking, the sociologists, psychologists, and educators having as much a part in systems analysis techniques; if the problems are in their areas, as the engineer does in problems with the DOD.

Dr. RAMO. Yes, Senator. I think a way to summarize that is to say that each problem has an optimum team. A good system job depends on understanding the nature of the problem well enough to identify the kinds of specialists as well as generalists one needs. A good systems engineering team for a problem is one that is properly interdisciplinary in nature, not just is interdisciplinary in sociology, but in the total socioeconomic sphere involved.

It appears to me that implementation of systems engineering, systems analysis, systems design, or systems management to the social problems that are unsolved and urgent before the Nation requires us, first of all, to recognize that this is a broad pervasive methodology. Everyone, in a sense, should be using quantitative commonsense where it is applicable, and it is applicable to some extent everywhere and has been for all time.

Having recognized this, in seeking to improve the implementation of this methodology it is important to find ways to disseminate what systems engineering is and to encourage its broad use. This is what these hearings are doing and what these various bills in one measure or another seek to accomplish.

It means that, like arithmetic, you would not expect to set up a special operation or a special agency to use arithmetic for the Government. You would expect everyone to use it.

I do not think this is too much of an exaggeration. It is an exaggeration if one tries to be overly rigid and procedural on a very simple problem. But whether you are designing a way of taking care of your family budget or designing a chair, a railroad, an intercontinental ballistic missile system, a hospital, or a water pollution system, you obviously want to understand the problem, the interaction of the various variables, and you want to use the modern tools which are available.

This means throughout government, city, State, local, regional, Federal, in all of the agencies, this methodology to one or another extent has applicability.

Unless one recognizes the pervasive nature of this, the best implementation is not likely to arise.

The problem comes when you want to really do something, such as take the Mississippi River and improve the situation as to pollution, and recogni[illegible] that in order to get something done you not only need to have an understanding of what it is you want to do, and have it well thought out, which presumably comes from the study side, the preliminary design side, but you want to arrange a structure of management to get it done, to arrange the funds and to arrange the coordination of the whole.

This is multiple agency in nature. As a systems engineer, but not an expert in political arrangements, I can only offer perhaps one view of this. That is to say that we cannot expect to reorganize Government so that there is always a single agency with clear, total control over any one of these social problem areas which today are multiple agency in nature.

We will have to learn to live with the idea that when you want to do something about one big area of national life that needs attention, the problem usually overlaps into other areas. Government will always be organized so that various segments of it have responsibility for some piece or other of the total area or problem.

You will rarely have a situation as good as, let's say, the Manhattan project or the intercontinental ballistic missile program, where total responsibility and control of funds to get a project done could be put into one agency.

I do believe, though, that having recognized that we have to live with this multiple agency problem, we can, for most of them, arrange what has to be done as a clear-cut, well-defined project, and give primary responsibility to one or another agency. Ultimately we will have to learn to do this, and expect the other agencies who have a part to heckle, to some extent to have veto power—but not total veto power—and to fight through the problems of interactions between agencies.

Systems engineering, well done in support of a primary project agency, or I should say the agency that has primary responsibility for a project, can do something that perhaps is the real center core of workability. That is, it can bring out the facts, it can be objective, it can show what is the soundest thing to do, and it can provide that which ought to be somewhat a controlling guide to all of the agencies involved.

Senator NELSON. To use your example of the Mississippi River, it is perfectly clear that a systems team could evaluate all the factors that are causing the pollution of that river, and could evaluate, industry by industry, the amount, nature, and character of the pollutant going into the stream; evaluate the cost of requiring each industry to install treatment equipment that meets the highest current status of the art; and do the same for the municipality side.

It could do all these things and then state the cost, both public and private. Then it could also make an evaluation of the benefit, the cost-benefit ratio, of having a clean river.

In other words, the benefit gained by the municipality and the industry in being able to take in clean water and use it versus taking in dirty water, cleaning it, using it, and returning it dirty.

It could also evaluate the value, from a recreation standpoint in two terms: One, just the environmental value of people living better, which you wouldn't measure in dollars; and the other an estimate of the economic value from a commercial recreation standpoint of having a clean river running all the way from above the Twin Cities to the Gulf of Mexico.

You could do all those things and stop there if you wanted to. You could do all those things with a systems analysis team.

Dr. RAMO. Yes.

Senator NELSON. And without a team of some sort you would not ever end up doing it. St. Louis can't do it, or Minneapolis and St. Paul can't do it.

You can do that and could quit there, and everybody in all the political units would have the necessary information to do something if they wanted or were able to do something.

This is the question that always seems to baffle the systems engineers, the political implementation. There would not be any reason at all why you could not then proceed to say, "Here are methods of solving this problem at the political level: One, you can apply the system to the Mississippi River Basin that the Germans applied to the Ruhr Valley, which involved numerous industries and communities."

You could suggest the Ruhr Valley solution. You could suggest regional planning commissions. You could suggest that the Federal Government establish water quality standards, set dates and enforce it. There would be three methods, but you could think of more.

The point is you could continue then and analyze proposed political solutions. Unlike when you are dealing with DOD and you propose a solution and the Defense Department says it is fine and they go ahead and do it, that situation would not apply here. But you could suggest feasible alternatives that the most creative people could think of, and then it is up to the Federal Government, the State governments, to proceed or not proceed. But at least they have before them a proposal, or several proposals.

Is it not correct that using systems analysis you could do all that I have just suggested?

Dr. RAMO. I think everything you have said is correct. I would like, if I may, to add one or two other points as a citizen, not as a systems engineer. I would find it very disappointing for us to stop any department from attacking these problems in a logical way, but I would be even more disappointed if we limited ourselves simply to studies bringing out the facts.

I would hope that as these facts were brought out as a nation, we would in parallel find our total voting public, our total citizenry, so convinced of the importance of the benefits to society, of the savings economically, that they would support implementation of improvements in all of these fields.

Therefore, my thinking cannot help but go to the question of how do you best insure that implementation proceeds? I think we agree it tends to be easy when the problem is of such a nature that the bulk of the problem is confined within a particular agency, whether geographical or whether at the State, county, or Federal level.

The real problem, the big problem, is the kind that crosses these various levels. It crosses States, it crosses counties. It crosses in another sense: It crosses funding problems. But only if the solution is going to be applied again and again wherever there is that kind of problem can you justify the tremendous amount, let's say, of development in order to implement the logical solution.

This means that inevitably the Federal Government would appear to be involved. From the standpoint of logical systems management it would seem possible to understand the problem in such a way that you could have a high-echelon systems level at which the interactions and the broad specifications are laid out and controlled. Perhaps to a considerable extent that means the funding must be controlled at that level.

Then you decentralize major segments of implementation, but you have, in effect, audit and control so that each segment is done within overall specifications and with proper interrelationship with the rest.

In a sense this is no different from what we did on the intercontinental ballistic missile program, which was the biggest systems engineering program we have had in the Nation, and which was big in another sense: It was a crash program. We were trying to do in 5 or 6 years what should normally, by the average of our previous performance nationally, require 15 or 20 years. We had to envisage the entire system. When we finally saw this system clearly enough, going through again and again a chicken-and-egg problem, we then could specify what the propulsion system needed to be so that propulsion specialists could bring that system to completion, could test and check it out at the right time, and would find it compatible, harmonious, and near optimum to meet the overall missile requirement.

We couldn't design the whole system in such a way as to properly specify any single segment without considering that segment in great detail first. And we couldn't design that segment without also considering the whole system first. Part of the expertise in systems engineering is to learn how to handle this chicken-and-egg problem of interrelationships. Once you have done this, it should be possible to delegate projects for implementation, and, as I say, audit and control to see that they are meeting the specifications that have been set.

If they find undiscovered problems as they implement—and when you actually do something, you run into experiences that you never get out of studies alone—you must be in a position to consider any changes required in the whole system because of interactions. You must always be on top of the whole problem.

I imagine then that we will find a method of implementation which will involve leaving Government to a first approximation, unchanged as each project arises.

This is not to say we won't have modifications, of course, continually, at all levels of government. But we will not change plans for each project. Rather, we will find a way initially to make the total technical direction at the top—at the proper level—and then decentralize the pieces while continuing to maintain systems project coordinative management over them.

In this way we will get the job done.

Senator NELSON. The problem is still the same as the problem you deal with in the Department of Defense. Ultimately the Department of Defense has to say that one of the alternative proposals you have made is acceptable to them. When you do the work for them, you can't make that decision. It is not within your authority. DOD would not delegate it to you.

Dr. RAMO. That is right.

Senator NELSON. And the Department of Defense may ultimately say, "We like alternative No. 1," which cost x dollars, "and that is acceptable to us," and then DOD also has to get the money from Congress.

The problem is the same on the Mississippi River. It is a tougher problem, a more complicated problem, it involves more units of Government. And it does not involve national defense, which sells itself.

But when you do get through with the Mississippi Valley evaluation, somebody else politically is going to make the decision as to whether or not and how you would implement the work that has been done by the team of systems analysts.

That is why I suggested at least in many cases it would be valuable, and in fact I think critical to a successful project, that political methods of solution be suggested.

One that I neglected which would be more obvious would be a Mississippi River Valley commission with the authority to implement its decisions. It then is clothed with governmental authority. Congress can do that.

That would be just one other political solution. The only point I am making is that I think you can always make suggestions for political solutions, and analyze all the possible ones. Once you have done that somebody at some political level is either going to have to accept it or reject it, just as the Department of Defense does.

Dr. RAMO. Yes, Senator. I think good systems work in support of the Government can do two things to help in this regard, backing up the statements you have just made. One is it brings forth the various possible solutions and shows the tradeoffs and the benefits versus cost.

It shows the complexity, the interactions with existing society structures. With all of this information available so that it is not a matter of guesswork, emotion, or hunch about things that are very complicated and in which there would be enormous differences of opinion. It is to a greater extent a matter of seeing the facts in clear outline.

There is another thing that systems analysis can do. I put this from my background, which is not political but rather managerial. I put this under the heading of "Management." When you see the system, what people and machines are going to be doing, when you see how you implement this, when you see the timing and the costs, the

geographical location, the interconnection of material and information flow that makes the whole thing work, when you see the tasks assigned to people who are part of the operations, then you see also how to break it up so that its parts are manageable in implementation and in operation.

You try to arrange management so that responsibility, authority, implementation, and control are consistent with one another. Good systems work naturally suggests organization of effort. I think this is in support of the remark you were making, but using the systems managers' language.

Senator NELSON. Where do you find systems analysts and how do you train them? Where are they being trained in this country? I am told there are a half dozen places, but I am only really aware that Carnegie Institute claims to be the one. What is a systems analyst?

Dr. RAMO. Ten years ago some of the questions that came up in these hearings also came up within the technical fraternity. I had occasion to write a paper on this subject which I reviewed to see if I might want to submit that for the possible aid of your staff.

I think your staff has a copy of that paper. It is 10 years old. It shows systems engineering is not new.

Senator NELSON. The reason I raise this question is frequently people in the field say, "Where are you going to find them?" That gets around to the question of what is he, what qualifications does he need, can he be trained in an educational institution, or can he only learn by experience?

When I was Governor of our State, I had a man who headed up the department of administration who only had a bachelor's degree. He was a budget analyst by background. But he was a genius as a systems analyst. There wasn't any problem of any kind that you could not throw at him and automatically and instinctively he knew how to tackle solving that problem whether it was in his field or not. But he had no training for it. He had an instinct for analysis in administration.

Where do you find these people? How do you train them and what qualifications do they need?

Dr. RAMO. Let me be very responsive to that question. I brought up the paper because it has some comments on this subject. You might want to look it over afterward. The colleges of the country, the universities, by and large, today, are doing something and something very useful about systems methodology. They are doing it in engineering schools, the engineering colleges, the engineering departments of major universities. They are doing it in business management. They are doing it in economics departments. But they are not beginning to do enough.

It turns out there is quite a lag between the recognition of the need for and potency of intellectual disciplines and the arranging of the teaching of them. We usually tend to start from case studies of something new. We go with case studies for many years before we find the proper kind of philosophical educator-type of individual who culls out of these many examples the fundamental generalizations. This is going on.

There is another thing the universities are doing: They are teaching the tools. One tool, for example, is to learn how to use a very

large computer to simulate, to put down quantitative relationships and to process these so that you can create, in effect, a mathematical model. This has been, of course, discussed in detail before this group.

Universities are teaching some of this. The universities are beginning to teach now, but not adequately, that all real live problems have an infinite number of possible solutions, no one of which is perfect.

A typical problem in college is: "Given this condition, what is the answer?" Real live problems, however, are statistical in nature. They involve probability. You never can state perfectly and with exactitude any part of the problem or the total problem. For example, there is always noise in the radio system, there is human error in putting down records, there is the leaving of the phone off the hook—something you did not expect people were supposed to do when you designed the system.

You have all of these things that go wrong and you have the problem of simply coming up with the best solution by some kind of criteria that you must learn how to establish. There is the multiple-parameter problem, the interdisciplinary problem.

What really happens, then, is that right now, before the universities have yet had the opportunity to fully embrace this subject in order to prepare a good systems man—but are nevertheless doing part of the job—systems men are discovered. They are people of talent, such as the individual you mentioned, talent to have the proper combination of interest in the total of the problem, the ability to rise above the special details and yet see their interaction, to be interested in the interdisciplinary facets, to be the kind of a person who is as interested in the socioeconomic side as well as in the purely technical.

When you discover these people, they are usually graduates of some special field. They may be graduates of engineering or of economics. A man that was a computer designer, or another one that up until that time did market research, finally gets drawn into embracing more of a problem and begins to be interested in its interactions. He learns these tools.

Senator NELSON. This is precisely the question I was asking because that is the impression I had.

The systems engineers I have known—quite a few of them—never went to school for it. They came out of business here or government there; they came from someplace, and suddenly they are in the systems analysis field. That is true of some very topnotch people who are in the Federal Government, in DOD, in NASA. So far as I know none of them went to school to become systems engineers.

My query is: Are you just going to find them by accident?

Dr. RAMO. No, I think in the future you can expect that there will be individuals whose formal education will be on systems. In a number of universities today it is possible to major in systems in one way or another. There are departments with that title in a number of our colleges and universities. There is something I think that even overrides this, however, in importance: A shortening of our educational system, a shortcoming of what you might call our intellectual discipline professional system.

If you ask for a quick definition of what engineering is, and to distinguish between engineering and science, they will tell you that engineering is the application of science to the problems of society.

Then you would expect a man who calls himself an engineer, who has been trained for this, who has had a formal education, to spend about as much time, or to spend a premeditated, arranged amount of time, in understanding society well.

How do you apply one thing to the other if you have only studied the one?

Senator NELSON. That is one general definition of an engineer. But we do not turn them out. We turn out electrical engineers, for example.

Dr. RAMO. We turn out engineers trained on the technical side of engineering by that definition. All engineering schools and colleges require a certain amount of social sciences and humanities, but they do it largely so that the individual will be broader, be a better father, a good citizen, but not because it is part of his professional qualifications.

Senator NELSON. He usually takes courses against his will.

Dr. RAMO. There is some of that, although there is less of that now, to be fair to these youngsters. We need social technologists, we need to train—with a premeditated arrangement—the political-econo-socio-technologist. We need to recognize that we need more individuals who are hybrid in their training, and whose job it is to work in the field of interdisciplinary science or interdisciplinary social arrangements.

I think we will work toward this, but we certainly won't do it fast enough but what for the next 10 years it will be true that most systems experts will be individuals who have chosen that area, who have come into it, but whose specialty originally as to formal education and early professional work was simply engineering, mathematics, sociology, and so on.

Senator NELSON. But it is in your judgment, then, possible to set up courses within academic institutions which aim at producing systems engineers?

Dr. RAMO. It is. It is difficult, always, to do something new. But there are backgrounds which can be taught just as well as any other course we already have. It is an urgent thing to create more individuals who are specifically steered in this direction.

It may be hard to find out what individuals have this talent early, but it is also difficult in the freshman year of pre-med to find out whether that individual ought to go into medicine, into law, or into a political life.

Senator NELSON. And he may go into it and finish it and may not be any good, too.

Dr. RAMO. That is right.

Senator NELSON. Did you give us all of the examples of the social fields that you have had experience in?

Dr. RAMO. I have made the comments I had in the back of my mind as being topics it would be well to discuss to be helpful beyond what was in the previous testimony.

Senator NELSON. I assume if the committee has some questions which require further elaboration we could send them to you?

Dr. RAMO. Yes. We would be prepared, of course, to give you abstracts or discussions of the numerous other projects TRW is involved in—in land use, in water, in various aspects of medical and health problems, and transportation problems.

Senator NELSON. If you have any material which you think may be valuable for the record, we would appreciate it if you would send it to us. The record will be open for 10 days after the hearings have concluded.

Dr. RAMO. Thank you very much.

Senator NELSON. I thank you very much for a very fine presentation.

Dr. RAMO. Thank you.

(The material referred to, subsequently submitted by Dr. Ramo, follows:)

SUPPEMENTAL STATEMENT OF DR. SIMON RAMO, VICE CHAIRMAN OF THE BOARD, TRW, INC., CLEVELAND, OHIO

In addition to this broad discussion on the subject, I would like to describe, in detail, a few specific projects in which TRW is involved. I believe these activities are of the type this Bill contemplates utilizing to a greater degree.

HEALTH

Edmonton Health Sciences Centre

This $100 million medical center is being developed by the Province of Alberta, Canada. The six-year project will involve the design and construction of ten buildings, in the development of a major medical complex that will provide patient care, education and research.

In a project of this magnitude and complexity, systems analysis is an essential tool to aid in planning, evaluating alternatives, and preventing schedule slippages. TRW is also designing a fully integrated communications-logistics-data handling system, so that ultimately anything that moves—information, supplies, etc.—in the complex will do so as part of this system.

Our systems analysis effort should reduce construction costs, provide continuing review and examination of alternatives, optimize such factors as site location, and identify—in advance—potential delays or other problems.

Our design and information systems effort is expected to lead to substantial reductions in operating costs over the life of the complex, and to enable operating efficiencies never before realized in a medical center of this type.

Regional Medical Program

This federal program evolved from the deBakey Presidential Committee on Heart Disease, Cancer and Stroke. The program contemplates methods for making available on a broad basis the medical excellence that now exists within the nation's medical schools and related teaching hospitals.

The program is federally funded, but administered on a regional basis. We are under contract to the Northern New England Region, with the University of Vermont as its centroid. Our role is to provide analytical and technical support and to work with local and regional agencies as the "engineering member-of-the-team," to plan and implement the regional objectives.

This activity demonstrates one method of employing engineering innovation towards the solution of civil or social problems. Our engineers are working together with regional and local representatives of the medical profession, hospital administrators, public health authorities, and educators, to create a harmonious ensemble that can bring to play all the resources necessary to a frontal attack on the nation's three killer diseases: heart, cancer and stroke.

Department of Defense Hospital Feasibility Study

Several months ago TRW completed a hospital systems study for the Department of Defense—in which we were teamed with Beckman Instruments and the architectural/engineering firm of Daniel, Mann, Johnson & Mendenhall. Purpose of the study was to examine the feasibility of applying advanced engineering techniques to the operation of existing military medical facilities, and to the design of future military hospitals. Feasibility was established; the studies clearly demonstrated that significant operating cost reductions could be realized through the employment of the systems approach in the initial design of a medical facility.

Automated Medical Examination Systems

Another happy marriage of engineering and medical profession is in the making with the advent of the speedy, inexpensive—but comprehensive—medical examination. Here again, the application of advanced engineering technology can lead to a systems design and improved methods of integrating the various subsystems, so that the product will be a superior means of providing medical examinations and a more effective method of utilizing the latest advances in medical diagnosis.

Transportation

High Speed Ground Transportation (Northeast Corridor)

The problem of moving people within the so-called "Northeast Corridor" is one of the nation's most critical transportation problems. The Office of High Speed Ground Transportation (HSGT), which will be an element of the new Department of Transportation, has contracted with TRW to perform analytical services and technical support, leading to the system definition of an optimum High Speed Ground Transportation System for use in the densely populated corridor between Boston and Washington, D.C.

Under this program, we will analyze the various subsystems and provide technical syntheses that will permit the HSGT office to select the system that will best meet the intercity transportation requirements. Our engineering analysis will be supported by specialized research and cost studies, as necessary, to assure the successful completion of the project.

Airline Transportation Problems

Although TRW's participation in the solution of the numerous airline problems is still relatively minor, this is an area in which advanced technology is essential to help overcome the congested airport situation, airline scheduling, flight separation, and terminal-to-city ground transportation.

Work is progressing on technical solutions to these technologically-caused problems. These solutions will involve such advanced techniques as the employment of communications satellites for relaying voice communication between aircraft and ground, improved air traffic control systems, and the development of computer scheduling techniques.

Urban Systems

California Land Use Information System

TRW is currently under contract to the State of California to develop a regional improved land use information method. The project has the specific objective of providing the means for more effective sharing of information between departments within a government jurisdiction, and between jurisdictions.

The project requires the determination of needs for land use data, the development of criteria to satisfy system requirements, and the design of a land use information system within the framework of the prospective federated information concept in the State of California.

Then, using Santa Clara County (California) as the base, TRW will demonstrate the operation of the proposed system.

Again, through the application of sophisticated engineering techniques, and with the aid of the big computer, we will be able to handle problems, and mountains of data in a manner that will vastly improve efficiency and reduce costs. Another example of the benefit of applying modern technology to government-oriented problems.

Law Enforcement

Authorities in the law enforcement field say the only way they will be able to cope with the growing urban crime problem is through the employment of the latest technological advances, particularly in communications, electronics and information storage and retrieval.

Take, for example, the deployment of police patrol cars and other emergency vehicles. We now know that a mobile system's efficiency can be improved threefold, through the use of modern communications, display devices and information systems. As I mentioned earlier, the Los Angeles Police Department hopes to solve some of its problems along these lines. Other police departments around the country are also exploring ways of obtaining more law enforcement at less cost, by utilizing advanced engineering techniques.

WATER

Ground Water Simulation

TRW is currently under contract to the San Bernardino Valley Municipal Water District, in California, to perform computer simulations and analyses of ground and surface water flows in the San Bernardino Valley. The simulations will portray water distribution and movement, to assist municipal, industrial and agricultural users in identifying underground watercourses and locating potential sites for wells, etc.

Another objective of this computer-based effort is to explore, analyze, evaluate, and present a range of possible plans for the coordinated use of ground and surface water resources to meet the increasing water needs of the area.

Desalination

For the Office of Saline Water (U.S. Department of Interior), TRW is studying membrane processes such as electrodialysis and reverse osmosis, to desalinate water economically. Information derived from our studies of the biological mechanisms of ion transport is expected to lead to the development of more efficient membranes capable of operation for prolonged periods and low temperatures, low pressures, and with minimal energy requirements.

A systematic and comparative investigation of certain salt transport characteristics is also underway to determine the relationship between the divergent salt tolerance properties of these bacteria and membrane structure and function.

As you can see from this varied activity, there are numerous places where systems engineering, information systems, electronics and other advanced technologies can make significant contributions to the solution of many of the problems facing us today.

We think we speak from experience when we endorse this legislation; it will provide a mechanism to bring the nation's full technological resources to bear on its civil, social, biological and economic problems.

Senator NELSON. We have one more witness, Dr. Robert Lekachman.

Before we proceed with that witness, however, we will take a brief recess to give the reporter a moment to rest.

(Whereupon a brief recess was taken.)

Senator NELSON. We will now resume the hearing.

Our next witness is Dr. Robert Lekachman, chairman, Department of Economics, State University of New York, at Stony Brook, Long Island.

STATEMENT OF DR. ROBERT LEKACHMAN, CHAIRMAN, DEPARTMENT OF ECONOMICS, STATE UNIVERSITY OF NEW YORK, STONY BROOK, LONG ISLAND, N.Y.

Senator NELSON. Doctor, we are very pleased that you would take the time to come here this morning and present your views to the committee.

Mr. LEKACHMAN. I feel privileged to be with you, Senator. If it is your procedure, I will present the statement I have drawn up.

Senator NELSON. That will be fine.

Were you here during the presentation of the previous witness?

Mr. LEKACHMAN. Just the last 10 minutes or so of it.

Senator NELSON. I was going to say you could make any additional comments you wished to on that statement.

You may proceed.

Mr. LEKACHMAN. Thank you, Senator.

As a social scientist, I naturally rejoice at the power of the techniques comprised under the heading of systems analysis. These are analytical tools which, as previous testimony to this committee has indicated, promise superior solutions to some of the increasingly serious

ailments of an evermore crowded urban society—the problems of traffic management, waste disposal, crime control, and the like, which have proven only moderately amenable to the piecemeal, ad hoc, uncoordinated methods of current practice and tradition.

An economist, in particular, finds himself in sympathy with the new approach because from its inception as a field of specialized study economics has been concerned with the efficient allocation of resources. Each society, including affluent America, perceives resources as scarce in relation to the almost infinite variety of ways in which they can be used.

Hence, any technique which improves the efficiency with which a society uses its scarce supplies of talent and capital is blessed.

Therefore, I endorse the legislation which Senator Nelson has introduced to promote public experiment with the new techniques and I look with anticipation at attempts in California, New York City, and elsewhere to apply the new tools on a scale large enough actually to alter and improve the urban environment.

Nevertheless, it is extremely important to suggest some of the limitations of systems analysis as it might be applied to social and economic problems.

If we are indeed on the verge of making extensive intellectual and financial commitments to a new mode of reasoning about public affairs, we need to be clear about what we can gain and also what we are unlikely to gain from the new outlook.

Let me start wtih some of the issues of principle involved in placing quantitative values upon the social and individual preferences of ordinary citizens. Intelligent advocates of systems analysis are frank to concede limitations upon the capacity of their technique to assign numerical weights to some of the important variables in social or, for that matter, military problems.

What they very properly prescribe is the measurement of the measurable, the identification of the unmeasurable, and the evaluation of what has been measured and what has resisted measurement by the appropriate decisionmaker whether he be the Secretary of Health, Education, and Welfare, the mayor of New York, the chief of a local police force or, possibly, a member of a legislative body.

Although the logic of this prescription is impeccable, the outcome is something else again. The temptation to misuse of the method is substantial. Since by hypothesis some elements of certain problems cannot be measured, an official or a businessman may reach his conclusions by ignoring in practice all considerations which do not yield to measurement.

I may make the point clearer by recalling a familiar academic dilemma: How do we decide whom to promote to a tenure position in a university department? Almost everywhere formal policy stresses teaching, research, and service to the university as the prime criteria of evaluation.

Few institutions, possibly none, will knowingly promote a researcher, however gifted, who is an utter catastrophe as a teacher. The rub is, how do we measure good teaching? By enrollments? High enrollments may indeed testify to enlightening teaching. Unfortunately, they may only signify that the teacher is an easy grader, an entertaining showman, or a dispenser of small assignments.

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Thus, it is that everywhere lipservice is accorded to teaching, the great unmeasurable, and conclusive actual weight is given to research, the great measurable.

Numbers imply precision and certainty, the resolution of doubt, and the end of indecision. Unless we take care we shall imperceptibly move toward a condition in which numbers and techniques determine the kind and the quality of the decisions which we are capable of making.

In this context it is relevant to ask how extensive use of systems analysis will affect the quality of our politics and the path by which we reach public decisions.

If I may, I shall quote a portion of an evaluation of the automation commission report which I made in the May issue of Commentary magazine:

> Just as Robert McNamara has used cost effectiveness and program budgets to rationalize the $60–70 billion which the Department of Defense annually expends, we can apply cost-benefit and systems analysis to the programming of social spending.
>
> As a proposition this is exceedingly seductive. It amounts to a recipe for cool research rather than hot politics, orderly university training rather than untidy street demonstrations, and the forging of a consensus out of rational thought rather than out of conflict of ideologies and interests. Even if the picture misrepresents reality, one would like to believe that its central premise can be turned into a creative social myth of the sort which persuades people to behave in new ways.
>
> That is why it is a pity that so little in our recent experience or our immediate prospects lends plausibility to such a vision of orderly social change. As it happens, our technology has been quite adequate for a long time to reach certain social goals. * * * We do not need systems analysis to send larger checks to welfare clients; nor are there any technical obstacles in the way of liberalizing training allowances, educational grants to the talented sons and daughters of poor families, and unemployment compensation payments.

To put the matter baldly, systems analysis can unquestionably aid us in achieving ends upon which we are reasonably united as a society.

Therefore, it is quite possible that in the next decade general public support for Federal auto-safety standards, effective control of pesticides, and genuine assaults upon pollution will permit important advances in rational techniques of social planning.

These are environmental hazards which afflict everyone and if systems analysis, computer science, and cost-benefit analysis measurably increase the safety of the city and the countryside, we shall all have cause to be grateful to their exponents.

But it is equally important to identify the kind of issues where conflict, not consensus, is likely because basic conflicts of interest or valuation exist. Of the many examples which might be offered, let me point to four.

The first is the choice which we make steadily between tax cuts and increases in public spending.

Federal taxes at current levels of gross national product are $20 billion lower each year than they would have been at 1963 tax rates.

This is a sum which could have financed substantial increases in public employment, education, urban housing, and health care, as well as a generous negative income tax into the bargain.

As a society we decided that increased private spending by the prosperous was a better use of additional Federal revenue than an enlarged program of benefits to the needy.

This sort of choice represents the interests and the valuations of the prosperous, as it must. If the bulk of prosperous America were to conclude, as it has not, that slums and poverty were blights upon our society substantial enough to warrant personal sacrifices to eliminate, then systems analysis would have something to say about the most efficient way to go about the job.

My second illustration relates to housing, a related area, in fact.

Suppose that tomorrow building technology were modernized, craft-union sabotage of efficient practice defeated, and ancient building codes granted decent burial. Our progress to decent urban housing would still be blocked.

The enemy is the persistent racial prejudice which has prevented substantial construction of low-income housing in the suburbs and confined growing numbers of Negroes and Puerto Ricans to central city ghettos.

Important social changes are far more likely to occur when the interests of the politically potent are allied to the changes that when the techniques which make change easy have been developed.

Indeed, I would add here that if there is a strong enough desire to make social change, then the techniques probably will be developed which will lend effect to the wish.

A third illustration concerns tax equity in local-State circumstances.

Last year, Mayor Lindsay proposed to tax the incomes of both commuters and New York City residents at similar rates. What the State legislature finally gave him was the authority to impose one set of rates upon residents and a very much lower set of charges upon the commuters to the city.

Imagine, contrary to the fact, that the mayor had had available a cost-benefit analysis of commuter tax payments and the value of city services to commuters. Would the clear conclusion of such a study that the commuters pay less than their fair share (which everybody suspects already, and possibly even the commuters) really persuade commuters to accept with good grace a new tax which their political power and personal influence might enable them to avoid?

LOCAL IMPROVEMENTS

As a final example of the fluidity of actual political issues, let me cite a trio of controversies currently agitating the residents of Suffolk County where my own university is located.

The State road department has proposed to widen Route 25A, a picturesque but narrow and winding road which currently bears a heavy traffic burden. Robert Moses, among others, projects a bridge to connect Long Island with Connecticut. One of the possible sites of the long-disputed fourth jetport for the New York metropolitan area is located in Suffolk County.

How shall we decide whether to make these improvements? Certainly the most careful calculation of benefits and costs should be made. But after they are made the argument has only begun. Inevitably the experts will value homes and business properties less highly than will their owners. Even if this were not the case, the experts are unlikely to agree with the partisans of scenic beauty, space, trees, foliage, and sanctuaries for wildlife.

In the computer age politics is still about power and influence. It may be entirely rational for powerful persons to conclude that their own interest, their own influence, and their own profit fail to coincide with a decision which rational social analysis demonstrates to be beneficial to the community.

What I have said permits of easy summary. It is an American temptation to substitute technique and method for open argument about values and priorities. Overemphasis upon technique and neglect of genuine conflicts of interest and valuation is a sin to which social scientists in particular are subject.

I reiterate my support of the legislation before this committee, but I must add at the same time that undue emphasis upon systems analysis or any other technique of social choice is likely to produce complacency about such issues as the distribution of income and wealth in our society, the crippling effects of racial prejudice, the equity of our tax system, the capacity of powerful, special interests to have their way, and the limitations of human sympathy which combine to defeat the most rational of social calculations.

Thank you very much.

Senator NELSON. I think you make several important points. In particular that if there is not acceptance by the decisionmakers at the political level of a solution to some problem, it is not going to happen.

I would make the point that sometimes, frequently or always, perhaps, if you have the analysis of a problem, with a demonstration of its cost, its need, and it is a compelling analysis it may not be politically acceptable today, but it has influence over a period of time.

In a number of instances in my own State on issues which were unacceptable to settlement 10 or 12 years ago, suddenly are being widely discussed and will shortly be acceptable.

So I think even though a solution to a problem is not acceptable immediately, if all the facts are presented to the public, I do think it has its impact over a period of time in causing changes.

Wouldn't you agree with that?

Mr. LEKACHMAN. I certainly would agree with that, Senator. If I were being cheerful about a proposal which I personally support, some form of negative income tax, or income maintenance, I would have hoped that over a period of years this particular approach is going to gain support, not only because it appeals to human altruism, but because it may be demonstrated that it is a less expensive way of providing for social welfare needs.

Yet I suppose that what runs through my mind is partly a question—I am far from an expert on systems analysis—about whether this is a technique that is as neutral as it appears to be.

I caught just the final minutes of Mr. Ramo's testimony, so I should not comment upon that. But let me say just generally that I think it is going to make a significant difference whether the practitioners of this new technique are primarily trained as engineers, or whether they are primarily trained as social scientists.

I don't mean by that to suggest anything as unfair, by way of comment, as a bias on the part of either group. But what I am suggesting is that it is a bias of an intellectual type which is imparted by the training.

I think very broadly, and perhaps I am saying this somewhat rationally, the engineering approach does place very, very heavy emphasis upon what is already immediately measurable, and social scientists, although they have certainly yielded to some of the same temptations, are at least by training more likely to try to measure some things which are currently very difficult of measurement, indeed.

I suppose I have in mind when I say that such things as local road improvements which, from an engineering standpoint, may look entirely feasible, and where the opposing interest may be indeed the proponents of trees, natural beauty, and some residential graciousness in the area.

I don't know how you quantify this sort of thing. All I am airing, I suppose, is the suspicion that if a heavily engineering approach becomes the dominant one in systems analysis, there will be variables which will be either ignored or neglected.

The universe of a physical planner is a great deal more tidy than the emphasis of the social planner. The emphasis on tidiness is one which I mistrust in this analysis.

I am suggesting, in fact, something like this, as I was saying in my formal paper, that where there really isn't very much social conflict I can see great and immediate possibilities for systems analysis.

But where there is real social argument I have a suspicion that the technique, itself, is going to become a part of the argument rather than a resolving force.

Senator NELSON. The example you gave of the highway happens to be one in which you and I couldn't lose. The engineers, who have had the responsibility for the highways, if they were subjected to a systems analysis technique would probably be required then to give some value to environmental quality, whereas what they do now is draw very straight lines and are not so concerned about such matters.

Here is where with the systems analysis technique you would come up with environmental and scenic beauty values which would have to be given consideration by the highway engineers who have traditionally not given consideration to such factors.

I think any system we use has whatever bias in it the people of the system themselves have. We may not be able to avoid being influenced by that. But I would consider it a poor systems analysis team that did not have representatives on that team of people who were authorities on all aspects of the problem that they were analyzing.

If they do that, I think it provides some protection. I agree with you, that you certainly can become an exponent of a system to the point that it is such an infallible technique in the engineering field, in the defense field, and so on, that whatever results that technique produces in the social field may find more acceptance in the community than it ought to have. I would agree with that.

I thank you very much for your very fine presentation and appreciate your taking the time to come before the committee and give us the benefit of your advice.

Mr. LEKACHMAN. Thank you, sir.

Senator NELSON. The committee will resume hearings tomorrow morning at 9:30.

(Whereupon, at 11:20 a.m., the subcommittee recessed, to reconvene at 9:30 a.m., Thursday, January 26, 1967.)

SCIENTIFIC MANPOWER UTILIZATION, 1967

THURSDAY, JANUARY 26, 1967

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON SCIENTIFIC MANPOWER
UTILIZATION OF THE COMMITTEE ON
LABOR AND PUBLIC WELFARE,
Washington, D.C.

The special subcommittee met at 9:30 a.m., pursuant to recess, in room 4232, Senate Office Building, Senator Gaylord Nelson (chairman of the special subcommittee) presiding.

Present: Senator Nelson (presiding).

Committee staff members present: Stewart E. McClure, chief clerk, and William Spring, special counsel to the subcommittee.

Senator NELSON. We will continue the hearings this morning on S. 430, Scientific Manpower Utilization Act of 1967, and S. 467, National Commission on Public Management.

Our first witness is Dr. Charles Kimball, president of the Midwest Research Institute, Kansas City, Mo.

We are pleased to have you appearing before us this morning. You have testified at other hearings before us and we have found your contributions very valuable.

You may proceed however you wish.

STATEMENT OF DR. CHARLES N. KIMBALL, PRESIDENT, MIDWEST RESEARCH INSTITUTE, KANSAS CITY, MO.

Dr. KIMBALL. Thank you, Senator.

Senator NELSON. I unfortunately did not get a chance to see your testimony in advance, so perhaps you better read it so I can interject any question I may have.

Dr. KIMBALL. Fine, I have a prepared statement here, Senator, that is 20 pages. It is really too long to read. I will just abstract from this.

Senator NELSON. The full text of Dr. Kimball's testimony will be printed in full in the record.

(The prepared statement of Dr. Kimball follows:)

PREPARED STATEMENT OF DR. CHARLES N. KIMBALL, PRESIDENT, MIDWEST INSTITUTE, KANSAS CITY, MO.

I am pleased to have this opportunity to enter into your discussions about the systems approach, and in its application to many problems of national concern. Because these issues do invlove a multidiscipline point of view with a strong mission orientation, I want to say a few words about the independent not-for-profit research institutes and their role—present and potential—in the enormous task of resolving social problems and building stronger cities and regions across the country. As I understand them, your discussions and your legislative con-

siderations have asked how we in this country can best apply our resources—human and financial—to make progress at a faster rate: to begin to catch up with the problems generated by growth and change, before they catch up with us.

I am not an operations analyst nor am I an expert on systems analysis, and, therefore, I am not equipped to use the proper jargon. I am an engineer by training, exposed during the past quarter century to all the different languages used in science and technology. I now find business english a more comfortable language.

The "systems approach" is an overworked and poorly defined term, but it can be descriptive. I would use it to include three characteristics:

1. An inter-dependence between subsystems or building blocks, and the whole problem,
2. Performance requirements which have a major anticipatory aspect, and
3. A full awareness of the fact that an economic analysis of the social cost of any one part of the system must recognize its impacts on all the other parts.

I prefer, however, to say that systems analysis, at least in my language, is a "point of view" supported by many clever, useful, and mostly new analytical techniques or devices. It is a good discipline because it demands that we consider problems as a whole, define our terms, separate ends from means, identify true costs, and understand the relevance and priorities of countless factors and interfaces which bear on any given problem or situation.

It is not a "black box" procedure to be accomplished by a computer because too many of the forces relevant to any problem we will discuss canot be quantified.

My main mission today is to put the group of organizations we call independent not-for-profit research institutes into something of a time perspective. I want to comment on who they are, where they came from, and where I believe they intersect with the subject at hand.

There are ten or fifteen institutes that are usually named when one lists the independent not-for-profits. In the aggregate they employ about 7,000 people and their total research volume now reaches about $230 million annually. Thus, they account for roughly 1 percent of all the R&D work funded in the United States.

The largest in terms of staff and research volume are Battelle Memorial Institute at Columbus, Ohio and Stanford Research Institute at Menlo Park, California. Then come a group of middle-sized institutes—our own at Kansas City; IIT Research Institute at Chicago; Cornell Aeronautical Laboratories; Southwest Research Institute at San Antonio; Franklin Institute Laboratories at Philadelphia; Mellon Institute at Pittsburgh; Southern Research Institute at Birmingham; and Research Triangle Institute at Durham, North Carolina, There are some recent additions to the list such as Gulf South Research Institute in Louisiana; Spindletop in Kentucky; North Star at Minneapolis; and a new institute which MRI helped to organize just last year in Rhode Island. You will note from this list that we have pretty well covered the United States map.

We refer to these organizations as "independent" because they operate under their own corporate charters, and most of them are independent of formal ties to other institutions. Each of us, however, enjoys multiple professional working relationships with a number of other institutions, universities and other pertinent groups, which enables us to expand our resources in quality and quantity as needed.

The majority of the institutes were founded in the late '40's when leaders in various parts of the country recognized the need to conserve and reorganize the regional research capability built up during World War II, and to expand upon this. If you examine the charters of these institutions, ours for example, you will find that most of them were founded by groups of regional business leaders, who recognized 25 years ago the need to apply science and technology to build up industry, to develop new products, to increase productivity and to contribute to regional growth and problem solving.

The Internal Revenue Service categorizes these institutes as tax exempt organizations. Each has, to varying degrees, received tax deductible contributions from private industries, individuals, and foundations, largely for plant and equipment. Each is controlled by a board of governors or trustees. All institute employees receive specific stated salaries, have no equity in the insti-

tutions, and receive no part of any net proceeds. None of these institutes seek contributions to defray operating costs in any substantial ongoing way. Each seeks to recover all operating costs from its project sponsors, plus an increment which is used to finance research, otherwise unsponsored, to improve experimental facilities, to fund special technical educational programs, and to provide required working capital. In most instances, the increment of income over expense permitted for projects sponsored by governmental agencies is more modest than for projects for industry.

It is encouraging that we are today discussing problems which so closely fit the charted objectives that were set forth in Kansas City over two decades ago. I say it is encouraging because in the past 25 years many of these institutes have had to look outside their own regions to find an adequate market for their talents.

Our founders hoped that we would work for regionally based industry and for the smaller companies who then had least access to research. While MRI has done this for the material benefit of several hundred companies in our region, yet most of our industrial research as measured in dollars has by market enforcement, been done for the giants of industry with headquarters in New York, Chicago, Los Angeles and other large cities.

Our founders envisioned these institutes also as a strong resource for state and local governments in their own region—yet by far the larger share of the government work of each of these institutes is performed for federal agencies.

Our founders saw, at the end of World War II, a chance to apply the nation's scientific talent to the problem of peace and the civilian economy, yet the larger proportion of work these institutes have done for 20 years relates to defense. This has not been a matter of personal preference for most institute professional people or for institute managements. It has been dictated by the marketplace and the hard economics of research.

Most of these institutes have neither endowment nor unearned income and so must generate all of their income from contracts. To retain and attract competent professional people, to purchase new equipment, and generally keep the house in good order in good times and bad is a very difficult task. Yet I believe you will find that each of these institutes has consistently put its best efforts into the forefront, into the leading edge of technology application where the market is always thinnest. In the rarefield atmosphere where truly new and original concepts are generated, it is nearly always impossible to sell major innovations, whether they are products, concepts or new marketing approaches, at anything like their real development cost.

I believe the institutes have an enviable record in this respect. I would point to the development of the Xerox process at Battelle after it had been rejected by a number of companies. Or the breakthrough in banking automation made at Stanford Research after being termed infeasible by many hardware developers, or the development of magnetic wire recording at Armour Research Foundation, now IITRI. Or the development of solid film lubricants at our own institution which may have application to maintenance and machine performance. These and many many other breakthroughs would have taken much longer if left to private industry alone, because the development economics, or payout looked fairly remote at the time.

I suggest that there is a direct analogy between the development problems of these very tangible benefits and the problems you are considering: getting new management concepts and analytical techniques usefully applied to our public problems.

I am very much encouraged by the changes I now see taking place in the nation. Most important is the increased understanding that systems analysis and all the other contemporary tools of problem diagnosis and solution can indeed be applied to civilian and social problems, just as they have been so successfully used on space and defense hardware problems.

At the same time, we see a clear and rapid emergence of what Joseph Kraft and others have called "the contract state". All this really means is that governments at all levels, institutions and private industry are learning the lessons of systems analysis. They are learning to contract for whole programs rather than piecemeal projects. They are learning to contract for systems management rather than just the design of systems. They are learning that—with great care—certain aspects of social and political responsibility can be contracted out to professional managers whose performance can be carefully monitored. It is

this conceptual breakthrough, rather than systems analysis itself or its attendant techniques which will make the major difference in our future national and regional rate of progress and development. Let me quote from Max Ways, writing in Fortune Magazine last month:

"The new style of dealing with the future offers to millions of living Americans an opportunity far more significant than material progress. Since Socrates, at least, Western civilization has respected the examined conclusion, the conscious conclusion, the conscious connection between thought and action, the intentional life. That we are now developing a set of more effective methods for shaping the future represents a fundamental advance along the main line of social and individual evolution."

Clearly, systems analysis offers a way to make major dents in major problems—especially in the long term. But when one speaks about applying these concepts at the local or regional level he runs immediately into problems.

First, there is a serious shortage of human resources to apply these techniques. Systematic analysis of any region's problems requires all of the skilled assets you have been discussing in these hearings. Interdisciplinary groups are needed because of the diverse variables in any systems problem, be it a transportation system, a health system or even a good city management system. These people must be "systems oriented" and they must have a good understanding of the subject being analyzed. They must have a coherent approach. They must also be regionally oriented when the problems are regional—that is, fully aware of and sensitive to peculiarities, personality quirks and folkways, social and business customs, of the region they are dealing with. They must share, in fact, a store of "house wisdom" about the more subtle relationships of the area they serve. Like a salesman, they must know the territory.

A second major problem is the need for exposure time—a period of initiation and incubation during which state and local government people and the private leadership can get used to systems approaches. It will take years, not months, for local governments and state governments to convert their affairs to the Programing-Planning-Budgeting Systems approach, especially for the early pioneers. Yet we believe at MRI that within a decade most major cities will have made the switch. If state, local and regional governments can adopt these formalized management approaches as rapidly as private industry has adopted formalized long-range planning concepts—a process which has been widely expanded in the past decade—they will be doing very well.

Third, there is the problem of money with which you gentlemen are also concerned. Well designed and well managed systems in the public sector may not cost less; they might well cost more. Their virtue is that they may also produce more, way out of proportion to the increased costs. But once state and local governments or regional groups are ready to move, they must have new funds to work with, since the old systems cannot be closed down while the overhaul takes place. Federal funds which recognize this need are available now, but virtually all of the existing aid programs offer only piecemeal assistance. The regional medical programs of the Public Health Service are bringing systems analysis to bear on our health care delivery. The Section 701(b) programs of the Department of Housing and Urban Development offer some initial help on governmental reorganization at the state and local level. The Regional Commissions established under the Economic Development Act are beginning to help at the interstate level. But much more money will be needed when the process begins to speed up.

Finally, there is a very real problem of implementation—getting things done. All too often brilliant systems analyses end up on the shelf, like so many potentially useful research reports, because no one has thought through in advance the process of implementation and the selection of ends—on a priority of action basis.

It is too easy, when surrounded by charts, flow diagrams and computers full of cost data, to underestimate the real cost of human inertia at the application end.

I hope this will not be the fate of the exciting studies carried out by the four aerospace companies for Governor Brown, in the event that "too much" information has been disclosed for the state system to digest, with the time and funds available.

I believe that independent research institutes like MRI may hold part of the answer to these problems of skilled human resources, exposure time, money and implementation. Let me mention a few of the things we are involved in at MRI

as examples of a smaller scale approach. Like a good systems analyst, I will mention these in functional categories which correspond somewhat to the categories used in PPB. Let me also point out that almost every project we undertake contains an element of systems analysis, again dictated by the market place. Before we sign a contract, we must analyze with great precision exactly what the work flow, time schedule, equipment and manpower costs will be.

One functional category is transportation. In this area we have worked out computer planning models and demand studies for state highway departments, including Missouri. On another tack we are developing a socio-economic model to show the impact of certain railroad mergers, ranging from community development to the transportation patterns of specific goods and commodities. For a large city, we are looking at the alternate consequence of rapid transit fare rate structures. We have a whole range of transportation systems studies under way for private industry, ranging from profitability to route structures and long-term demand forecasting. Virtually all of these studies focus on a six- or nine-state region in the Middle West. Taken individually, these studies are bits and pieces in the big picture, though these bits and pieces are of vital economic importance to our clients. Taken together, these could represent the launching stage for a much more comprehensive systems approach to the transportation needs of the whole region.

They also might logically provide a base for work in some other functional areas. Take law enforcement or safety for example. Since we have under development a systems model of the Missouri state highway network, would not it make sense to utilize the data bank for law enforcement and accident data? One new aim would be to develop the best possible schedule for state highway patrol routes. This kind of planned spill-over from one area to another can be far less expensive than starting from scratch.

Or take environmental control, another area of pressing interest to every region in the country. Our analytical chemists and engineers have for a dozen years been helping cities, metropolitan areas, river commissions and private clients through systematic pollution surveys—both air and water—and the design of control programs. It might be wise to fill in the missing data links needed to build towards a regional model.

At the same time, MRI scientists and systems analysts are designing a national network to monitor pesticide residues in the human population. What is the best means to determine on a nation-wide basis which kinds of pesticides leave harmful traces among our people, and what are the medical effects? The resulting system must define what tissue samples are taken, where, when and from whom; how they are collected, transported, analyzed, and then how the data are employed to give the Public Health Service the answers it must have. This is a national problem rather than regional cut at one part of our total environmental control problem. In effect, it is a vertical slice, looking at a single problem area in depth. How much would it cost and what would be the benefits of a horizontal or regional slice of the total environmental control problem?

Another functional area of particular concern to our region is food supply. Over a number of years, MRI has developed a very remarkable program for the State of Nebraska. Nebraska has levied a one mil tax on real property, and with these funds has sponsored a research program to generate new end uses for their field crops. As one product, MRI has developed a new water soluble packaging film from amylose corn starch. The process was patentable. Nebraska now holds the patent and has licensed production to a private company, thus putting money back into this system through jobs and consequent economic development. How much better if this kind of novel approach could be extended to many states in a whole region?

As one final functional category, let me mention our cities and their problems of management. For one large city government, MRI recently completed a systematic analysis of all of the forms of federal aid available to it. Rather than simply cataloging federal aid programs, however, we attempted to establish cost/benefit ratios for each aid channel. Obviously, it costs a city government a great deal more to obtain a dollar of aid for some purposes than for others. During this study, we found not only that they had never measured their investments in these programs (in terms of time to process applications, counterpart funds, predicted time delays), but that there were a surprisingly large number of high return-on-investment programs which they had never even heard of. And this was a city larger than San Diego, with a comparatively competent city hall staff. The project was an eye opener for them, for us, and for the

Department of Housing and Urban Development, which we now expect to sponsor further study along the same lines.

I bring this up as an example of the sort of highly applied systems analysis which is likely to help the groups you are concerned about most in the near term. It is also typical of the kind of innovation, coupling technical skills with social and economic insight, people have come to expect from these institutes. I believe that we can help local, state and regional groups in many such ways at a pace they can accommodate and at a cost the nation can afford.

For some areas, as I said a moment ago, these research institutes may be the wrong place to look for help. The universities, for example, have a vital role to play in longer terms, involving more basic research with much less immediacy of results. For some fields, where intensive concentration, a vertical, in depth cut, on a single subject of great national import is needed (highway safety, law enforcement, for example), special national institutions patterned after NIH might be desirable or required.

At MRI we have long had a hand in the process called technology transfer, and in fact we were the first regional dissemination center set up by NASA in 1961 to interpret and disperse to the private sector (some 500 midwestern companies) advanced technology developed by NASA.

I think that is essentially what we are looking for here today. It is unlikely that any state, city or region can afford the development costs of a new tool as valuable as PPBS or even critical path scheduling. What our states, cities and regions need is help—and continuing help—in understanding, adapting and using the tools that are already available. Since our institutes stand or fall on their performance record, we have made it a habit to attract as many expert "appliers of science" to our staff as possible. These people are by nature "transfer agents" who become acutely unhappy when the results of their work end up on a seven-foot shelf. Without implementation, unsuccessful follow-through by our clients, our overall performance record would not look as good as it does today.

I say all this because, as you well know, our skilled human resources in this country are stretched very thin, and this is particularly true with regard to talent which can and will be helpful to state, city and regional governments. As you consider the problems, then, I urge you to consider these institutes as a resource already in being, trained, staffed and equipped for the large part, to do the job these people need.

Let me be more specific. I see at least several ways to increase the regional value and regional impact of these institutes. I believe these are some of the means to the ends we seek:

We can do much more of the kinds of work we presently do for state and available the information needed for more effective government throughout our region.

We can do much more of the kinds of work we presently do for state and local government, either by scaling up the size of the problem area we work with, or by adding to depth and continuity of our research and support services.

We can develop continuing research and consulting arrangements with various governmental groups, on a drawing account basis.

We can provide the vitally needed link between private industry and the public sector in critical social problem areas like housing, city renewal, job training or medical care. We find that the companies are willing if their risks can be minimized, and we know that state and local governments are ready to experiment. The missing link is the matchmaker who creates a workable market place in objective, impartial and apolitical terms.

In collaboration with certain universities, we can create highly pragmatic training programs for state and local government people, to help speed the transfer of systems management know-how and other techniques. This is a logical extension of the technology transfer programs which we have successfully developed for NASA and the Office of State Technical Services.

These are the kinds of directed help which will produce results. It is clear, however, that neither the institutes nor the governmental groups involved are now in a position to pay the cost of such programs. At the same time, I can tell you that these research institutes would welcome a greater opportunity to fulfill this role. It would mean, for MRI at least, an opportunity to intensify the accomplishment of the chartered objectives set forth nearly 25 years ago, but in a much more effective and meaningful way than founders visualized at that time.

I am convinced that the answer requires something more consistent than the

historical project by project approach. What is needed is funding for sustained programs which can carry over the peaks and valleys of local need.

This is exactly the kind of relationship which could be established between institutions like our own, and the state or local authorities, if funds could be made available as outlined in your legislative proposal. I want to stress my belief that the multiplier value of a sustained relationship—can be much greater than a single project attack alone. For instance, we are now engaged in a long range tax study for the State of Missouri, forecasting potential revenue and expenditure growth. The value of our work is heightened, I feel sure, because we "know the territory". Our final recommendations or alternatives for tax reform will reflect MRI's aggregate house wisdom about the region, and will be all the more pragmatic for it. This is the "common sensical" element, which Mr. Henry Rown, the new President of Rand, has suggested is so badly needed if the results of systems analysis work are to be successfully applied.

How much more effective could our efforts on such problems be if we could maintain the working relationship over years, instead of weeks or months? How much better if we could find a way to maintain and support continuing dialogue between the experts and analysts of our staff and those in state and local government burdened with the operational problems?

A good example, for your consideration, might be the Mississippi Research and Development Center which, although barely under way, has been conceived as a means to provide state agencies and the rest of Mississippi's leadership with just such continuing help and analysis. While some of its operations are supported on a project by project basis, both under federal and state programs, the sustaining funds come from special appropriations of the State Legislature. It seems likely that the type of funding to states which you have proposed could greatly magnify the achievement of that organization.

A short time ago, in a different approach, the Carnegie Corporation's acting president, Alan Pifer, suggested that general support grants be made directly to independent research institutes by the federal government, just as DOD and NIH now provide sustaining and general support grants to universities. I can see many benefits in providing part of such support through the states by the legislative mechanism you have proposed.

A further extension to this general approach might be sustaining grants to research institutes to couple one or more of the activities I have mentioned earlier. An additional reinforcing element might be training grants to permit us to bring in people from various levels of government and from universities, and expose them to new techniques in the working research environment.

As a final piece of perspective on the independent research institutes, let me cite one or two numbers. Our staff at MRI totals about 400 persons, with an annual research volume of approximately $6 million. Over the past two decades we have accumulated research experience at a total value in excess of $50 million. I believe that it is vital to the progress of our region, our states and our cities that we find a way to transfer and build upon the value of this accumulated experience.

Over the past several years, we have made important selective additions to our professional staff so that MRI could respond vigorously to the increasing requirements of the public sector at all levels—municipal, county, state and federal.

Your proposal can link a closely knit, coherent, sociologically conscious research group like MRI to state and regional problems on a continuing basis, and can trigger many multiplier public benefits.

Our in-house knowledge would thus be kept current, tuned to tomorrow's issues, and put to work where it is most needed—at the right time and with minimal start-up effort.

In spite of their small number and relatively small portion of the total national R&D budget, these not-for-profit institutes are high leverage organizations, almost uniquely equipped to have a major impact on the regions they serve on a continuing basis. They offer a singular resource in terms of multiple discipline expertise, relevant to the pressing public problems of the time, in terms of broad familiarity and understanding of the most advanced analytical and implementive techniques, in terms of established relationships as trusted sources for scores of governmental units at all levels. And they are eager to extend their useful contribution, to respond more forcefully to the needs of the regions of which they are a part.

Dr. KIMBALL. I am glad to be here today because the issues you are discussing are related to a multidisciplinary point of view.

One of the subjects I want to treat today is the role, both present and potential, of the independent, not-for-profit research institutes, and the role they could play and have played in building stronger cities and regions.

I understand that the question you are discussing here is how, in this country, we can best apply our resources, both human and financial, to begin to catch up with the problems that are generated by growth and change, before the problems catch up with us.

I should say at the beginning, Senator, that I am neither an operations analyst nor am I an expert in systems analysis, so I am really not equipped to use the proper jargon. I am an electrical engineer by training, and during the past 25 or 30 years I have been exposed to many of the languages that are used in science and technology, but I find business English a more effective way to express myself.

I would like to start by saying that systems analysis, in my language, is a point of view that is supported by many clever, useful and mostly new and analytical techniques and devices. It is a very good discipline because it demands, among other things, that people consider problems as a whole, define terms, separate ends from means, identify true costs, and understand, above all, the relevance and priorities of many factors and interfaces which bear on many problems.

Systems analysis is not a black-box procedure to be accomplished by a computer. In fact, too many of the forces involved in the things you are discussing here cannot be quantified.

My main mission today is to put the group of organizations which are called independent, not-for-profit research institutes into something of a time perspective. I would like to comment on who they are, where they came from, and where I believe they intersect with the problem at hand.

When this category of nonprofit institutes is discussed, usually 10 or 15 are implied or included. In the aggregate these organizations employ about 7,000 people and their total research volume is about $250 million annually. Therefore, they account roughly for 1 percent of the total R. & D. expenditures in the United States.

The largest of these in terms of staff and research volume are Battelle at Columbus, Ohio, and Stanford Research Institute on the coast. Then come a group of middle-sized institutes; Midwest Research at Kansas City, the Research Institute of the Illinois Institute of Technology at Chicago, Cornell Aeronautical Laboratory at Buffalo, Southwest Research at San Antonio, Franklin Institute at Philadelphia, Mellon Institute at Pittsburgh, Southern Research Institute at Birmingham, and the Research Triangle Institute at Durham, N.C. There is Denver Research Institute, too, in Colorado.

Senator NELSON. These are all nonprofit?

Dr. KIMBALL. Yes, sir.

There are some recent additions to this list, recent in the last few years—Gulf-South Research Institute of Baton Rouge, Spindletop in Kentucky, North Star in Minneapolis, and a new institute which we helped to put together last year in Rhode Island. So you can see from the list that they pretty well cover the map of the United States.

These groups are called independent, because they operate under their own corporate charters, and most of them are independent of any formal tie to any other institution. But they enjoy working relationships with other groups such as universities and consultants.

The majority of these institutes were founded in the late 1940's, when leaders in various parts of the country recognized the need to conserve and reorganize the regional research capability that had been built up during World War II, and to expand on this.

You will find if you examine their charters that most of these organizations were founded by groups of regional business leaders who recognized, 25 years ago, the need to apply science and technology to build industry, to develop new products, to increase productivity, and to contribute to regional growth.

The IRS categorizes these institutes as tax exempt; each of them is controlled by a board of governors or trustees. All institute employees receive specific stated salaries, have no equity in the institutions, and receive no part of the net proceeds.

It's encouraging to me today to come here and discuss problems that literally fit so closely the chartered objectives that were set forth in Kansas City 25 years ago. I say it is encouraging because over the past 25 years, many of these institutes have had to look outside their own regions to find an adequate market for their talents.

Our founders, for example, hoped that we would work for regionally based industry and for the smaller companies who then had less access to research. While MRI has done this for the material benefit of several hundred companies in our region, most of our industrial research, as measured in dollars, has been done for the giants of industry, I think this is characteristic of all of these institutions.

Our founders also envisioned these institutes as a strong resource for State or local government in their own regions, yet by far the largest part of work for governments by these institutes has been done for the Federal Government.

Most of these institutes have neither endowment nor unearned income, so they must generate all of their income by contracts.

To retain and attract competent professional people, to purchase new equipment and generally keep the ship in order in good times and bad is a very difficult task. Yet I believe that you will find that each of these institutes has consistently put forth its best effort, especially into the leading edge of technology application where the market is always the thinest.

These institutes have an enviable record in this respect. I will give you three illustrations. I would point to the development of the Xerox process at Battelle, after the same process had been rejected by a number of large companies. Or the breakthrough in banking automation, the first of its kind, made at Stanford Research after the system had been termed not feasible by many hardware developers. Or I would point to the development of magnetic wire recording at the Armour Research Foundation in Chicago, now called IITRI.

I would point to the development of solid film lubricants at MRI which may have wide application to maintenance and machine performance.

The point I wish to make here is that these and other breakthroughs, that I could allude to, would have taken much longer if left to private

industry alone, because the development economics, or payout, looked quite remote at the time.

And I would suggest that there is a direct analogy between the development problems of these very tangible benefits, and the problems you are considering, which I understand to be getting new management concepts and new analytical techniques usefully applied to public problems.

There is an increased understanding of systems analysis in the Nation, and all other contemporary tools of problem diagnosis. And I believe that the solutions can be applied to civilian and social problems just as they have been so successfully applied on space and defense hardware problems.

Governments at all levels—Federal, State, local, and municipal—institutions and private industry—are learning the lessons of systems analysis. They are learning to contract for whole programs rather than piecemeal projects; they are learning to contract for systems management rather than just the design of systems; and they are also learning, with considerable care, that certain aspects of social and political responsibility can be contracted out to professional managers whose performance can be carefully monitored.

It is this conceptual breakthrough, rather than systems analysis itself, or its attendant techniques, which will make the major difference in our future use of this new tool.

So systems analysis does offer a way to make major dents in public problems, especially in the long term, but when you talk about applying these concepts at the local or regional level, I see some considerable problems ahead.

First, there is a serious shortage of competent human resources to apply the techniques. The people who do this must be systems oriented and not merely mathematicians; they must have a good understanding, above all, of the subject being analyzed rather than only the technique they employ to analyze it. They must have what I call a coherent approach, and if the problems are regional, these people better be regionally oriented themselves. That is, they have to be fully aware and sensitive to the peculiarities, personality quirks, the social and business customs of the region they are dealing with. They must, in fact, share a store of "house wisdom" about the more subtle relationships of the State, region, or city in which they are working. I suppose I could paraphrase by saying that like a salesman, they better well know the territory. That's one problem, the serious shortage of competent human resources.

The second problem is the need for exposure time—a period of initiation, or incubation—during which State and local government people and the private leadership can get used to systems approaches. I think it will take years, not months, for local governments and State governments to convert their affairs to the program planning, budgeting systems approach, and especially will this be so for the early pioneers in the effort.

Yet, we believe that within a decade most major cities will have made this switch. And I say if State, local, and regional governments can adopt these formalized management approaches as rapidly as private industry has adopted formalized long-range planning con-

cepts, a process which too many people is relatively new, then these States, these governments will be doing well. That is the second problem, the need for exposure time.

The third one is the problem of money. Well-defined and well-managed systems in the public sector may not cost less. They may well cost more, but their virtue is that they may well produce more and, in fact, way out of proportion to the increased cost. But one State, local, and regional groups are ready to move, they must have new funds to work with, since the old system, that is, the way they are doing it now, cannot be closed down while the overhaul takes place.

Federal funds which recognize this need are now available, but virtually all of the existing aid programs provide only piecemeal assistance. The regional medical programs of the Public Health Service, for example, are bringing systems analysis to bear on health care delivery.

The 701 programs of HUD offer some initial help on government reorganization at the State and local level.

Senator NELSON. I might, if I could interrupt there, Dr. Kimball. The 701 grants have, I think, been a dramatic example of the time-exposure problem that you talked about. As of 7 or 8 years ago, there was very little understanding or consideration given to regional planning in this country. When the Congress made appropriations available under the 701 grants for State and regional planning, the result was an awakening of interest in planning.

Suddenly now, in the past 2 or 3 or 4 years, we see the rapid development of regional planning commissions all over the United States as a direct consequence of the inducement of the 701 grants.

Dr. KIMBALL. I perhaps should have mentioned a fourth point, that is, pride of ownership or pride of authorship, which oftentimes comes in importantly.

I would add to your comments sir, that the regional commissions that have been recently established under the Economic Development Act are also beginning to help at the interstate level appreciably.

The last problem in this regard I want to mention is perhaps the real one, and that is the problem of implementation, getting things done.

My own experience has been that all too often brilliant systems analyses end up on the shelf, like so many potentially useful research reports, simply because nobody has thought through in advance the selection of ends on a priority basis. They have paid more attention to means.

It is too easy when surrounded by charts, flow diagrams, and computers full of cost data, to underestimate the real cost of human inertia at the application end.

Now, I believe that these institutes, of which I represent one, may hold part of the answer to this problem of skilled human resources, exposure time, and implementation. If I may, let me mention a few of the things we are now involved in at Kansas City, as an example of a smaller scale approach.

I think this will illustrate what I am trying to say here. One functional category in the public concern sector is transportation.

In this area we have worked out computer planning models and demand studies for State highway departments, one of them being Mis-

souri. On another tack we are developing a socioeconomic model to show the impact of certain railroad mergers, ranging from community development to the transportation patterns of specific goods and commodities.

For quite a large city we are looking at the alternate consequences of rapid transit fare rate structures.

Senator NELSON. May I interrupt there for a moment?

Dr. KIMBALL. Yes, sir.

Senator NELSON. Are you in the process of developing a transportation plan for the State of Missouri?

Dr. KIMBALL. Yes, sir. Traffic plan, layout, optimum layout of highways.

Senator NELSON. For the use of the highway department?

Dr. KIMBALL. Yes, sir.

Senator NELSON. And the development of their highway system?

Dr. KIMBALL. It is a tool to forecast future traffic volumes on current and future highways.

Senator NELSON. But it is a plan that will predict where the traffic flow will be and what the traffic problems of the future will be?

Dr. KIMBALL. And where new roads will be needed.

Senator NELSON. Now, in the implementation of that plan, when you are through—for example, you will make a prediction based on your traffic studies, population studies, where it will be necessary to develop a highway system network. I assume that you will then be recommending to the highway commission that they will have to get into the hard problem of preemptive zoning?

Dr. KIMBALL. Our current efforts are limited to traffic volume studies, as I stated earlier.

Senator NELSON. Which ought to have been done all over this country, but I have not seen much of it done anyplace. We wait until everything is built and then we tear it all down.

Do you contemplate this poses a pretty tough political problem in Missouri? I don't know what their zoning laws are.

Dr. KIMBALL. Of course, in Missouri there are only two large cities, St. Louis and Kansas City, and many of the roads that we think will be needed are roads from those cities to other parts of the State like the Ozarks. For example, there is no really good road from Kansas City south.

You put your finger on a critical problem. Who is going to do something about it after these forecasts are made, and how are we going to overcome the problems that the planning effort then unearths?

Senator NELSON. If you are predicting 10, 15, 20 years in advance and you know, then, that a highway should be placed between two certain points and then you must zone it so it cannot be built on in the future. This immediately has consequences for the owner of the land that you are taking and some rather dramatic consequences for the abutting landowner, who is going to have an enhancement of value to his property just based on the zoning, which is really just a prediction that you will build a highway there someday. Of course you might change your mind because the facts may change in the next 10 or 15 years in some unanticipated way.

This seems to me to be the tough part.

Dr. KIMBALL. There has been a lot of that going on. I understand that happens even today in large cities where the Interstate System has to go through.

Well, we have a whole range of transportation studies underway as well as private industry, that range from profitability to long-range forecasting.

The point I am making here, Senator, is that virtually all these studies focus on a six- or nine-State region in the Midwest. Taken individually these studies, in respect to the big picture, are just bits and pieces, but they are not bits and pieces in respect to the economic importance to the people who are getting them done, but taken together these studies—and I am sure other groups are doing similar things—represent a launching stage for a much more comprehensive systems analysis of the transportation problem of the whole region.

We have a whole group of building blocks that are not connected yet. They also might logically provide a base for working in some other functional areas.

Take law enforcement or traffic safety, for example. Since we now have under development a systems model of the Missouri State highway network, would it not make sense to utilize this data bank for law enforcement or accident data? One new aim, for example, might be to develop the best possible schedule for State highway patrol routes in the law enforcement sense.

The point here is that this kind of planned spillover from one area to another can be far less expensive than if you start from scratch. Or taken environmental control, another area of pressing current interest.

Our analytical chemists and engineers at MRI have for a dozen years been helping cities, metropolitan areas, river commissions, private clients through systematic pollution surveys, both air and water, and in the design of control programs. It might be wise to fill in the missing data links needed to build toward a regional model, and the basis of the air sheds that are now being discussed.

Now, coincident with this effort our people—scientists, systems analysts—are designing a national network to monitor pesticide residues to the human population. Here are some of the questions we are trying to answer:

What is the best way to determine, on a nationwide basis, which kinds of pesticides leave harmful traces among our people and what are the medical effects?

The resulting system, and we have the responsibility for developing this, must define what tissue samples are taken, where, when and from whom? How are these to be collected, transported, analyzed? How is the data that will develop from these to be employed, to give the Public Health Service the answer it must have?

Now, this is a national problem rather than a regional cut at one part of our total environmental control.

Senator NELSON. Has your institute done some work in this area?

Dr. KIMBALL. We are designing now the national program for pesticide residue observation and control, yes.

Senator NELSON. Have you any reports on it as of this date?

Dr. KIMBALL. Yes; two or three interim reports.

Senator NELSON. I am particularly interested in that because I have two pieces of legislation on the pesticide field myself for creation of a scientific evaluation team to evaluate the effects of pesticides in the environment. I am not sure that it is the best approach. That is why I would be interested in what you are doing.

Dr. KIMBALL. Yes, sir; I will get them for you.

Another fundamental area of particular concern to our part of the country is food supply.

Over a number of years MRI has developed a very remarkable program for the State of Nebraska. This State has levied a small tax on real property, and with these funds have sponsored a research program to generate new end uses for their field crops.

As one of several products we have developed a new water-soluble packaging from amylose cornstarch. The process was patentable. Nebraska passed legislation which permitted it to hold, as a State, the rights to the patent.

Senator NELSON. Are you the ones doing the work—somebody said to me, recently, we are going to reach the stage someday where we will eat the package as well as the contents.

Dr. KIMBALL. This could be done in this case and I have seen it done as a demonstration purpose, yes; amylose corn, of course, is edible, soluble, useful, of course, in packaging frozen foods. If you had frozen spinach, you put the entire package in a pot. When cooked, you are eating the package as well as the spinach.

Senator NELSON. My kids would rather eat the package.

Dr. KIMBALL. Well, these people have licensed production to a major company, which has built a plant in Nebraska, and are thus putting money back into the system through jobs and consequent economic development. How much better it would be if this kind of novel approach could be extended to many States in the region rather than one.

As one final functional category let me mention cities and their problems of management.

For one large city we recently completed a systematic analysis of all of the forms of Federal aid available to this city. Now, rather than simply cataloging Federal aid programs, we attempted to establish cost-benefit ratios for each aid channel. Obviously it cost the city government a great deal more to obtain a dollar of aid for some purposes than for others.

During this study we found not only that this city had never measured its investments in these programs, investments in terms of staff time to process application, counterpart funds, and predictable time delays, but that there was a surprisingly large number of high return on investment programs which they had never even heard of.

Now, this is a city larger than San Diego with a comparatively competent city hall staff. The project was an eyeopener for them, and for us, and also for the Department of Housing and Urban Development. I bring this up as an example of the sort of highly applied systems analysis which is likely to help the groups you are concerned about most, in the near term.

It is also typical of the kind of innovation which couples technical skills with social and economic insight, that people have come to expect

from these independent research institutes. So I believe that we can help these local State and regional groups in many such ways, at a pace they can accommodate, and a cost the Nation can afford.

Now, for some areas these research institutes may be the wrong place to look for help. The universities, for example, have a vital role to play in longer terms involving more basic research with certainly much less immediacy of results, and their problem is always of coupling with the private sector.

In some other fields where intensive concentration is needed, such as a vertical type cut on a single subject of great national importance—highway safety nationally, law enforcement, for example—then special national institutions might be desirable. I would suggest that these be patterned after the 9 or 10 individual National Institutes of Health.

At MRI we have had a long exposure in the process called technology transfer and, in fact, we were the first regional dissemination center setup by NASA in 1961, to interpret and disburse to the private sector, advanced technology developed for another purpose by NASA. We have been working now over these past 6 years with some 500 middle western companies.

I mention this because I think what we are looking at here today is essentially this issue of technology transfer. It is unlikely in my view that any State, city, or region can afford the development costs of a new tool as valuable as PPBS, or a tool as primitive today as critical path scheduling.

What our States, cities, and regions need is help, and continuing help in understanding, adapting and using the tools that are now available, let alone the ones that are going to be developed. Since the institutes like MRI represent or stand or fall on their performance record, we made it a habit to attract as many expert appliers of science to our staff as we can. These people are by nature transfer agents who, I must say, became acutely unhappy when the results of their work end up on a 7-foot shelf.

Senator NELSON. Let me ask a question here. Why do you think it is too expensive for a State or local government to develop a tool as valuable as PPBS.

Dr. KIMBALL. Well, it would be too expensive if they just started off on their own. I think they could start at an intermediate point, with some outside help from people who already know the subject.

Senator NELSON. Let me ask this question: On almost any one of these questions, whether it is crime, highway safety, pollution, are not almost all the solutions that one might come up with transferable? In other words, if a city such as San Diego did a crime study, police enforcement study—I realize there are differences among all cities—but if your institute did a systems analysis of a problem for a community of a certain size, generally speaking would not the results of your effort be transferable to another city elsewhere in the country?

Dr. KIMBALL. Yes, sir; give or take the differences between the cities, that is correct. We do not need basic research on this subject. We need more coupling from the source of knowledge to the people who need to have it.

Senator NELSON. So then, if, for example, the Federal Government were to adopt some version of two bills that are before us and were

then to make some grants for study purposes—regional, city, so forth—the results of that effort when the study was all over, would be valuable and usable in all parts of the country where the circumstances are roughly comparable?

Dr. KIMBALL. I agree. They would have what I call a very high multiplier effect; yes, sir.

Well, I have said what I have today because, again to repeat, the Nation's skilled human resources are stretched thin, and this is particularly true with regard to talent which both can and wants to help State, regional, and city governments, and as you consider these problems, Senator, I would urge you respectfully to consider these institutes as a resource already in being, trained, staffed, and equipped to do the job that these people need.

Now, let me be more specific. I see several ways to increase the regional value and regional impact of these institutes I have named. Here are just a few of them: Create regional data centers to collect, process, analyse, and make available the information needed for more effective government through a given region. We could do much more of the kinds of work we presently do, either by scaling up the size of the problem area we work with or by adding depth, or we could develop continuing research and consulting arrangements with various governmental groups on a drawing account basis, if you will.

Here is an important one, I think: We could provide the vitally needed link between private industry and the public sector, and there is a link needed here, in critical social problem areas like housing, city renewal, job training, or medical care. We find that private companies are willing to get into this if their risks can be minimized; we know that State and local governments are ready to interpret.

The missing link is this matchmaker, the coupling element, who creates the workable marketplace and objective, impartial, and apolitical terms. And the final point is that in collaboration with certain universities we could create highly pragmatic training programs for State and local government people to help spread the transfer of systems management know-how and other techniques. This is a logical extension of the technology transfer work we have done for NASA, and some of the efforts of the Office of State Technical Services.

These are the kinds of directed help, in my view, that have produced results, but it is clear also that neither the institutes I have mentioned nor the governmental groups involved are now in a position to pay the costs of such programs. But I can also tell you that these research institutes would welcome a greater opportunity to fulfill this role. It would mean in MRI's case, for example, an opportunity to intensify the accomplishment of the chartered objectives that were set in the middle forties, but in a much more effective and meaningful way than our founders could have visualized at the time.

I am convinced that the answer requires something more consistent than the historical project-by-project approach. What is needed is funding for sustained programs which can carry over the peaks and valleys of local need. I want to stress my belief that the multiplier value of a sustained relationship can be much greater than a single-project attack alone.

For example, another project case history. We are now engaged in a long-range tax study for the State of Missouri forecasting poten-

tial revenue and expenditure growth. The value of our work is heightened, I feel, because we know the territory. Our final recommendations or alternatives for tax reform will not only reflect our own aggregate "house wisdom," but it will be pragmatic as a result of it.

Now, this is the commonsense element, which Mr. Rowan of Rand has suggested is so badly needed, if the results of systems analysis work are to be successfully applied. How much more effective would efforts on such problems be if the working relationship could be maintained over years instead of weeks or months. How much better if we could find a way to maintain and support continuing dialog between the experts and the analysts, and those people in State and local governments who are burdened with the operational problems.

I have one example for your consideration to illustrate this point. There is a new group in Mississippi known as the Mississippi Research and Development Center which, although barely underway, has been conceived by the State government as a means to provide State agencies and the rest of Mississippi's leadership with just such continuing help and analysis. While some of its operations are supported on a project-by-project basis, either under State or Federal funding, the important point is that sustaining funds have come from special appropriations from the Mississippi Legislature.

It seems likely to me that the type of funding to States which you have proposed could greatly magnify the achievements of similar groups.

A short time ago, in a different approach, the Carnegie Corp.'s acting president, Allen Pifer, suggested that support grants be made to independent research institutes by the Federal Government, just as DOD and NIH now provide sustaining and general support grants to universities.

I could see many benefits of this. A further extension of this approach might be sustaining grants to groups like our own, to couple one or more of the activities I have mentioned earlier, such as training grants, to permit us to bring in people from various levels of government and universities and expose them to various techniques in the working research environment.

As a final point on this, let me cite one or two numbers. Our staff at Kansas City now numbers 400 people. It does an average annual research volume of $6 million. Over the past 20 years we have accumulated research experience working for some 900 private clients and 200 public clients, and the volume is in excess of $50 million. I believe it is vital to the progress of the region, the States and the cities in it, that we find a way to transfer and build on the value of this accumulated experience.

I will close with this comment, sir. In spite of their small number and their relatively small proportion of the total national R. & D. budget, 1 percent, these not-for-profit institutes are what I call high-leverage organizations. They get things done, they are almost uniquely equipped to have a major impact on the regions they serve. They offer a singular resource in terms of multidiscipline expertese which is relevant to these public problems of our time.

In terms of broad familiarity and understanding of the most advanced techniques, they also understand the consumer or clients' need,

and they have over a long period of years established relationships, in the sense of what I term trusted sources, for scores of Government units at all levels, and they are eager to extend this contribution to respond more forcefully to the needs of this region.

That is the end of my prepared or rather, paraphrased statement, sir.

Senator NELSON. The points you were addressing yourself to for the last 10 minutes have been precisely the kind of contribution that the committee is interested in.

Two years ago when I conducted the hearings on the allocation of scientific manpower, at which time you appeared, it was out of those hearings that we developed the idea, the proposal that is now before us. But I am not particularly satisfied with the way my bill is drafted. There seem to be some gaps—also in the other bills pending before us. One of them creates a national commission to evaluate the problem and propose an approach while my proposal authorizes the Government to make allocations of funds for the application of the concept of systems engineering to State governments, to local governments, to groups of one kind or another. But how to implement the program really is the question. Who is prepared at the Federal Government level to give it a broad spectrum look and say, here is the way we ought to proceed and here is the approach we ought to take?

I do not think we have anybody prepared to make that decision. I think it would be very valuable to have the consulting advice of research groups such as yours who have years of experience in dealing in both the private and the public sector, and my question is this: I am wondering if you could examine carefully the two bills that are before us and then prepare some suggestions on the best method of approach. We are probably going to merge the two concepts one way or another and, obviously, make a number of changes in them, and we expect to offer a bipartisan bill.

But no one I have talked to on the legislative side is really prepared to say that he has the best answer for how we ought to proceed. It would be helpful to the committee if you would only analyze these bills carefully and then write your suggestions upon how it ought to be done, who ought to allocate the money, what kind of advice should they have in allocating the money, what objectives should we seek to accomplish and how should we accomplish these objectives?

I think based upon the experience of your organization, the people you have there, that you probably could give us the best testimony that we can get on making this approach.

Dr. KIMBALL. We will give it a good effort, Senator.

Senator NELSON. Your testimony has been very valuable.

We will give the reporter 5 minutes.

(Whereupon, a brief recess was taken.)

Senator NELSON. Our next witness is Dr. Donald Schon, president, Organization for Social and Technical Innovation, Cambridge, Mass.

Dr. Schon.

Dr. SCHON. Good morning, Senator.

Senator NELSON. We appreciate having you appear here this morning.

You have a prepared text. Your text will be printed in full in the record and you may proceed to read it or extemporize or however you wish to present it.

STATEMENT OF DR. DONALD A. SCHON, PRESIDENT, ORGANIZATION FOR SOCIAL AND TECHNICAL INNOVATION, CAMBRIDGE, MASS.

Dr. SCHON. I think I will begin by reading and then cover the high points of the remainder.

I wanted to begin with a definition of this term "systems approach" since it has come to be used with such frequency and sometimes in so many conflicting ways.

I would like to define the term "systems approach" around a specific model which I think has some independent interest for this committee. This is the schools construction system development project in California, led by Ezra Ehrenkrantz. The rationale of that project, supported in its early stages by the Educational Facilities Laboratory of the Ford Foundation, has been described as follows:

> The why of SCSD is apparent in the gap between the increasingly complex, constantly changing demands being made on our schools, and the ability of traditional building practices and products to meet them. New teaching mehods and equipment call for new ways of arranging new types of instructional space.
>
> Changes in curricula, teaching techniques, organization and grouping of students and staff, require corresponding changes in buildings. And change is beginning to be recognized by educators as a continuing part of the educational scene. Upgraded educational standards point to an upgraded environment—good lighting, effective sound control, air conditioning, even carpeting. At the same time, the student population grows and shifts; budgets remain tight. In short, we are asking for more variety, greater flexibility, higher quality, and lower costs—a combination the schoolhouse can seldom provide.
>
> Collectively, schools form a building market second only to housing; but because they are built one at a time, schoolhouses do not offer the manufacturer enough volume to spur product development to meet new educational requirements. As a result, school architects must select from products which are developed independently, often for other building types, and therefore do not fit perfectly either the school's physical needs, its budget or one another. Too much of the architect's time is spent fitting together bits and pieces of material, instead of grappling with vital problems of program and design.
>
> In 1961, when SCSD was established, it was abundantly clear that such procedures—inefficient educationally as well as economically—were not the best answer to the demands of a decade in which taxpayers would buy $27.3 billion worth of primary and secondary public schools, and in which change would be the only constant. And it was becoming evident that current attempts at reform—stock plans, prefabs, portables, and so on—offered only limited solutions and were winning only limited acceptance. Certainly, no latter-day Henry Ford was in the offing, ready to start rolling identical schoolhouses off an assembly line.

What he did was to adopt a British model which focused on the problem of assembling a market large enough to attract industrial contributions to the development of new technology. He succeeded in doing this by inducing groups which formed a consortium which could guarantee markets big enough to support the development work and tooling. He then proceeded along the following lines:

1. The developing of new products designed specifically for schools.
2. Encouraging manufacturers to work together so that their products would constitute a system.
3. Guaranteeing a sufficiently large market for the products.
4. Finding a satisfactory way to bring products, producers, and purchasers together.

When he had assembled his market, he then began with a study of user requirements for a school. He began with the people who were

going to use them, teach in them, interact in them, and he focused on three basic sets of requirements:

1. Freedom in overall planning, from the single, large loft building to the multiunit, campus-style school.

2. The simple and economical arrangement of a variety of spaces in a variety of ways for a variety of purposes. For many of the districts the self-contained classroom for 30 students was no longer the basic teaching space.

3. Altering and rearranging these spaces as the need arises. In fact, one of the assumptions underlying the design criterial was that an average of 10 percent of the interior partitions would be changed yearly.

He then divided the basic design of a school into a set of component systems. These were the structural system, the ceiling lighting system, the air-conditioning system and the movable and operable portions. He did not select either the exterior brickwork or the plumbing because of special union problems.

For each of these it then became the objective of SCSD to develop performance criteria, that is to say, statements which indicated what the systems must do rather than materials or design specifications. SCSD was then in a position to go out for bid to industry and to attract large firms with major technical capability who would not have been attracted to the market offered by individual schools—for example, Inland Steel, Johns Manville, Hauserman Partitions and others. A bidding process was designed which involved perliminary qualifying bidding and the refinement of performance criteria on the basis of the capabilities of bidding companies.

That is to say, he engaged in the dialog with the companies testing performance criteria, testing what they could conceivably do.

While work was going on, efforts were also being made to bring school superintendents, local political leaders and, perhaps most important, union leaders into the building process.

Neil Haggerty of the building trades department of the AFL–CIO was selected to sit on his advisory committee. What he was attempting to do here was design the social process of getting buildings built as well as the system of schools themselves.

When bids came back and schools were built, they demonstrated improvements such as these:

First, long-span structures are usually too expensive for schools built within California State aid formulas. SCSD schools will get long spans, and the interior flexibility accompanying large, column-free space, for $1.81 per square foot. Structure for the typical school with a roof span of only 30 feet costs an average of $3.24 per square foot.

SCSD will provide air conditioning for all academic areas (but not such spaces as gymnasiums, kitchens and storerooms), with local temperature control for all spaces of 450 square feet or more, plus a 5-year maintenance contract, for only 34 cents more per square foot than California schools now pay for heating and ventilating alone.

The lighting-ceiling system, which not only meets stringent lighting requirements but also provides for air distribution, fireproofing, and sound absorption, will cost $1.31 per square foot, as against $1.67 ordinarily spent for ceiling plus lighting.

Although the specifications called for fixed as well as demountable and operable partitions, the demountable partitions turned out to be no more expensive than the fixed if educational work surfaces are included. The operable partitions, panel and accordian type, include builtin supporting framese that make them movable, too—a feature previously unavailable at any price. Yet this near-total partition flexibility will be provided for slightly less than the cost of conventional partitions.

Approximately five of these schools are under construction in California and others are under construction in this country, according to the plans Ehrenkrantz laid out in his problem.

I have gone at such length into this example because it illustrates some of the key features of a systems approach to public sector problems:

1. The object of inquiry was the whole system—the school and all its functions—not just a part or component of that system.
2. In the course of inquiry, the system was divided into interconnected subsystems.
3. For these subsystems performance criteria were developed.
4. A process was set in motion which led to the making of a variety of alternative inventions meeting these performance criteria.
5. Through the consortium of school systems, markets were created which served to attract technological innovation.
6. The whole building process, including its social and political problems, was taken as a subject of study and an attempt was made to design that process.

The term "systems approach" is sometimes used as though it contained a kind of magic which is new to our time. I do not believe this is the case. Nevertheless, it has been one major consequence of our efforts in the defense and aerospace fields over the last 20 or 30 years—perhaps in the Manhattan project and the recent major projects of NASA more than in any other area—that we have begun to believe in the possibility of taking whole and analytical approaches to complex civilian problems. In my opinion, the key contributions of the "systems approach" in the civilian areas we are talking about, are as follows:

1. We now believe that we can attack certain complex problems as whole and analytically.
2. We have raised the level of aggregation at which they are tackled. We no longer talk only about filters or electrostatic precipitators, for example, brought about the whole problem of urban and environmental control.
3. We have learned the difference between materials and design specifications and performance criteria, which open up possibilities of technological innovation at the same time as they provide guidelines for performance.
4. We have begun to explore the mobilization of private industry to work on public systems problems—thus meeting Galbraith's excellent argument in "The Affluent Society" to the effect that private industry and the market mechanism had been effective in the development of the consumer products, but not in the

solution of public systems problems—and we have undertaken this mobilization by and large, through the "pull" of markets rather than through the "push" of Government intervention.

5. We have begun to use simulation techniques, and other tools of analysis, to handle system that present us with "more information than we can handle."

It seems to me these are among the principal contributions.

But there are some major differences between civilian public sector problems and military and aerospace systems problems which must be attended to. Their solution presents us with some of the principal challenges to this field. It seems to me there are principally two of these.

In civilian areas, each public sector problem—transportation, housing, water management, pollution control, education, and the like—is already a center of fragmented but tightly interconnected private activity. Each sector constitutes a more or less closed system, in which needs are met through a network of companies and other institutions which provide sets of interlocking products and services. Current technological solutions to the requirements of these sector needs tend to be locked in though: Specification-based standards, regulations, codes, fragmentation of market, and institutional boundaries.

An example is the field of housing, particularly low-cost housing, and the as yet unsuccessful attempts of major firms to enter that field on anything approaching a systems basis. In the last 10 years many companies—including Monsanto, Union Carbide, Johns Manville, United States Steel, and several of the aluminum companies—have attempted to take a systems approach to housing—that is, to attack the housing problem as a whole. They have invested amounts varying from $1 to $12 million, to my knowledge, and have nevertheless had to drop their efforts.

The reason was, by and large, that they had greatly underestimated the total marketing cost—including distribution, sales, and merchandising—which would be required to crack these fields. They discovered that traditional product components—for example, 2 by 4's and cast-iron pipe—tend to be locked into place (a) by specification-based standards and an institutional structure for establishing the standards which is largely controlled by traditional firms and is highly resistant to change, (b) by building codes based on specification-based standards, and reinforced by (c) labor practices tied to current product.

Moreover, they discovered that whereas it was possible to work their way into one municipal system—for example, with polyvinyl pipe—each system tended to function more or less independently of all the others, and there were many thousands of such systems in the United States.

The total cost of cracking these systems—overcoming specifications, code, labor practice, and the institutional settings surrounding each of these—was far greater than any profit they could hope to realize, within a reasonable time, from their investment.

It is no accident that the principal innovation in housing in recent years has been the introduction of prefabricated trailers—many of which are transported to a site, put up on blocks and never moved again—and which now constitute about 20 percent of the housing

market. These have been marketed essentially in an end-run around traditional housing practices and have found their locations generally outside of municipal code areas.

Senator NELSON. May I interrupt a moment? That figure of 20 percent of the market is so startling, I want to ask you again, Is that accurate?

Dr. SCHON. Yes; In fact, I would guess that since my numbers come from a year or more ago, that number is somewhat conservative. That is 20 percent of the total housing starts.

Senator NELSON. Housing starts right as of——

Dr. SCHON. At the current time.

Senator NELSON. That statistic surprises me.

Dr. SCHON. Trailers have been a way in which it has been possible to industrialize the construction of dwellings, but not to market them as dwellings and, therefore, they have provided a loophole through the closed system of the building industry. It has been possible to take a systems approach to the construction and marketing of trailers and doing cost benefit analysis of their production in ways it has not been possible to do in traditional housing practices.

I think that roughly similar situations could be shown to exist in the fields of water resource management, education, transportation, pollution control and the like. In each of these areas, because of the social and institutional reinforcements of existing products, it is generally feasible to engage in improvement on a product-by-product or a component-by-component basis, but not to undertake approaches to these systems as wholes, and it is precisely tackling the problem of the system as a whole which gives its fundamental attraction to what we have called the systems approach.

There is a basic need, therefore, to deal with problems of social, regulatory and institutional innovation in order to open up public sector markets to technological innovation. I shall have more to say about this question later on.

Moreover, public sector problems affect people who use the systems and who cannot and ought not to be seen as cogs in a machine or as components of a "man-machine system." The humans involved in the Manhattan project or in NASA's Project Apollo are, for the most part, members of an organization charged with a mission to complete that project and they are under the direct authority and control of the project.

In areas of public systems we encounter a new category of people who are and want to be autonomous with respect to the system and who are not under its direct control. These are the people who act with, are affected by, and use the system. It is one step forward in this respect for us to begin to be concerned with user requirements, as in the school example earlier.

For example, the needs of teachers for flexible space.

It is an even further step for us to begin to be concerned with user and community participation in the design and implementation of these public sector systems. Failure to understand and work out these problems leads to poor design in the ultimate sense; namely, inadequacy to the needs of people; and then to lack of use, or even hostility to use of the system which has been designed.

The technological or social designer troubled by the hostile or uncomprehending attitudes of users of the system of services he provides, has become a common and troubling spectacle in our society. We need to learn how to plan and design processes which incorporate user requirements and user participation on all the levels at which public systems must be designed—in communities, States, and regions. We need to develop both models for doing this and ways of building the skills required to do it.

These, it seems to me, are some principal differences between aerospace and civilian areas which require major change in our views of how systems approaches can be applied.

Now, it seems to me there are some trends which are aimed at overcoming these problems, trends toward the introduction of systems approaches in civilian areas and they run roughly as follows:

First, there is a tendency for products to be replaced by systems as the business of industrial corporations. Industrial corporations have tended to define their business in terms of systems rather than in terms of products.

There is a trend for the involvement of private industry and business in public sector problems. And there is a trend toward the opening up of new public sector problems and markets.

Although progress in these directions is halting and stumbling, it seems to me that these trends seem to portend a major change in our use of technology and in our lives.

I would like to briefly illustrate some of these trends. First, with respect to what is now called the city business.

A large number of companies—among them General Electric, Westinghouse, Sunset Petroleum, and various aluminum companies—have begun to identify themselves as being in the "city business" rather than in the materials or product business. This has led them to move to the acquisition of large tracts of land, to the planning of the use of this land, and to the design for neighborhoods, communities and cities, rather than of individual buildings.

Companies like G.E. and Westinghouse see these cities not only as opportunities for the sale of traditional products like appliances, but as new opportunities for profit and contribution in themselves. It has been estimated that approximately 70 such new cities are in various stages of development and construction in the United States at the present time, which are associated with the moneys and efforts of large industrial corporations.

Senator NELSON. 70?

Dr. SCHON. Yes, that number comes from an analysis done by the General Electric-Temple Corp. in Santa Barbara. A new city now may vary anywhere from a rather large neighborhood development which incorporates industries, shopping centers, schools and the like, to like a city like Columbia between Baltimore and Washington, which aims eventually to include 50,000 people, which James Rouse has conceived.

I think for the first time, at least in our country and in our time, it allows one set of planners or designers to address themselves from scratch to the problem of the design of a city as a system.

Britain and the Scandinavian countries have had experience with

this before, but we have not in general. But we are having it now and large industrial corporations are having it now.

The second area is the area of crime control and prevention. I know this committee is familiar with the Aerospace General study of the California system of justice. My own corporation has been working with the District of Columbia and the National Crime Commission.

The Institute for Defense Analysis has worked for the National Crime Commission on applications of science and technology to the prevention and the control of crime, with special attention to the development of computer simulations of the system of criminal justice.

The District of Columbia Crime Commission has explored systems studies of the operations of its courts.

Arthur D. Little, Inc., has conducted studies in Philadelphia on the operation of the courts.

Under the National Crime Commission there has been the beginning of the development of a point of view which links the systems problems of the administration of criminal justice to overall community development objectives that we associate with programs like the poverty program.

A third example, we could characterize as a systems approach to community improvement.

During the last 6 months my corporation has been invloved with the Housing and Urban Development in the detailed planning of what came popularly in the press to be called the concept for housing.

This notion had certain key features to it. It wished to address itself to the problems of the improvement and rehabilitation of neighborhoods conceived as total systems. That is to say, we wished to look at the physical rehabilitaton of dwellings, at new construction, at the problems of management, financing and control, at the provision of essential community services and to maintenance of dwellings and at the problems of involvement of local groups on the neighborhood level in the management of these corporations.

Whereas, the large-scale national program which was conceived has not as yet been brought into being; a number of local projects in the spirit of the concept for housing are in the works. One of these is the recently announced Bedford-Stuyvesant project in New York City. Another is the 114th Street project in Harlem, in which the U.S. Gypsum Co. is heavily involved. There are projected community development projects which approach the problems along the lines I have just described in New Jersey, in Boston, and in other cities as well.

A fourth area of example is in what might be called the field of man-and-job matching. It was a consequence of the work of the Commission on Automation, Technology, and Economic Progress that a project was initiated with the help of IBM to explore the development of a large-scale system which would match occupational requirements, on the one hand, and skills and capabilities of job-seeking individuals, on the other hand, initially on a municipal and then on a national basis.

And a computer program and system for doing this is now under development.

The fifth area is in the health field. There is interest in planning for and the begininngs of work in the field of large-scale diagnostic screening systems. One of the areas in which these systems are being explored is in the health programs related to Indian reservations.

There are many approaches now being taken which are characterized as systems approaches to the functions of hospitals.

The Lockheed Corp., and Bolt, Baranek & Newman, among others, have addressed themselves to the problems of hospital information systems. Thompson-Ramo-Woolridge in California is undertaking work on the design of large-scale health facilities, using what they speak of as systems engineering techniques. And Federal agencies such as the Public Health Service now have begun serious efforts to reformulate their own programs in terms of what we are here calling the systems approach.

The sixth area of example is educational systems. I am sure you are familiar with the various combinations of private corporate ventures which have come into being as a result of the attractions of the educational market, so-called—they include the General Electric-Time combination, Raytheon, Litton Industries, and Xerox.

Among the developments in this field is the emergence of the idea that the design, management, and implementation of an educational system such as a junior college system or even the total skill and training needs of the community could be undertaken by private industry, under general community policy guidance.

Even more significant is the beginning, made by many communities at present, to define the objectives and performance criteria for metropolitan educational systems, and efforts to set in motion the planning process in the community aimed to bringing those systems into being.

A seventh area of illustration is in the field of transportation. Let me point to two among what I think are many illustrations here.

When I was in the Department of Commerce as Director of the Institute for Applied Technology, we undertook, with the Office of High-Speed Ground Transportation, what I think is the largest computer simulation of a transportation network which has yet been attempted. This was the computer simulation of all of the municipal modes and links within the Boston-to-Washington-corridor area.

The purpose of doing this was to provide a vehicle for evaluation of the various technological alternatives to the problems of transportation in the corridor; high-speed rail, vertical takeoff aircraft, and the like, which were and are being developed.

The corridor program is perhaps the single largest scale effort at a systems approach to intercity transportation currently underway.

Senator NELSON. This is a project you are working on now?

Dr. SCHON. No, sir. This was a project I was involved in when I was in the Department of Commerce.

My firm now is working, however, on another transportation systems problem which, I think, illustrates the trend we are here discussing, and this again with the city of San Diego.

I was interested to hear Charlie Kimball's reference to this area. We have formed a team with the city of San Diego, the county of San Diego and the Ford Motor Co., whose function is to take a systems approach to the long-range urban transportation needs of San Diego.

In many ways that approach is based on the model of the school systems project that I described earlier and has the following steps or components in it.

First, the development of user requirements for future transportation systems in the San Diego region.

Second, the formulation of performance criteria for those systems, including requirements for the phasing of one system with another and for flexibility.

Third, the involvement of user constituencies, groups of people, within the San Diego community in the process of planning out the city's requirements for transportation and, conversely, the effect of possible transportation alternatives on what the city wishes to become.

The point here being that the choice of transportation system will determine the future direction and character of growth for the city of San Diego.

And the development of performance criteria must be derived from its choices about the directions in which it wishes to grow.

Then, finally, the involvement of industrial corporations in a manner analogous to the school systems projects and the development of new technology to meet the requirements formulated in this fashion, so there will be an industrial competition and bidding process following the development of performance criteria for transportation systems as part of the San Diego transportation systems program.

Allied to the trends which I have illustrated is the fact that many new organizations have come into being to supplement the nonprofit corporations which have been in being for the last 50 years, which are concerned with systems approaches to technological and social changes.

One of these is the Organization of Social and Technical Innovation, a nonprofit corporation based in Cambridge, Mass., which I represent. In addition, a number of the aerospace companies, such as TRW Systems and Litton, have made significant strides in this direction.

Many universities, including, for example, Massachusetts Institute of Technology, University of Michigan, University of California at Berkeley, have developed or are developing programs and faculties designed to do research on the processes of public systems development, to undertake specific projects in this area, and to train people in disciplines and skills which are related to the problem.

All of this—the discussion of what the systems approach is, the major problems I see in attempting to transfer system skills from the aerospace and military to the civilian area and the trends in this direction that we can now see ongoing—lead me to a few suggestions or recommendations about how the character of these trends might be accelerated.

The first is this: I have indicated earlier that in every major public systems area the principal obstacle to pressing forward a systems approach for technological and social change is the network of regulatory, administrative, legal, and institutional factors which are tied to current technology and to current corporate interests in these fields.

What I am saying here is not the development of methodology and technology; it is the social and institutional change which would open up markets for the application of these skills, which, I think, is a far more difficult problem.

As far as I can tell, the problem of changing these factors is a separate one for each public systems area, frequently requiring State and local and Federal change in each instance, and may even be a separate problem for each municipl area in question. It does not seem to me likely, therefore, that legislative change could be effective on a broad national basis in solving these problems.

However, there may be institutional approaches which can be taken either by the Congress or by the executive branch to coordinate, keep track of, provide assistance in, and stimulate regular administrative, legal, and institutional change at the many local and State levels where they will be required.

Senator NELSON. May I interrupt there?

In the first sentence above it does not seem likely, therefore, that legislative change could be effective on a broad national basis. You refer to legislation that may remove local barriers to——

Dr. SCHON. Yes, sir; I am thinking, for example, of again the housing example. I do not believe it is going to be feasible to enact a national performance-based building code or to change through legislation the combination of private material suppliers, craft labor unions, regulatory agencies, code offices, and the like which make up closed system of the industry.

I think that has to be handled on a municipal, regional, State-by-State basis.

Senator NELSON. You would not say that would apply, however, to such problems as air pollution, water pollution. There are some problems there. But you could legislate nationally—we are doing some legislating nationally now. Air pollution is a regional and national problem as well as local.

Water is the same, and I think you can do all the legislating necessary there if the Congress really wants to. We have moved quite a way in this field recently. On a national transportation system problem you could solve that one also. We did with the I system. Not that we solved the transportation problem. But what I mean to say is, you have the authority on a national level and it is feasible on interstate travel involving highways, rail and so forth.

But you were referring particularly to a number of local problems, which I suppose would include the problem of policing crime and the problems of buildings and housing codes?

Dr. SCHON. I think there may well be many areas in which national legislation can provide funds to undertake programs which no region or local area can adequately provide funds to do. There may be some areas, as you have mentioned, which have interstate characteristics to them where it is possible to put into being regulations which would then stimulate the thinking at local and regional levels.

But the kind of institutional and regulatory and administrative barriers to changing these fields which I have encountered for in my own business today, it is hard for me to see that national legislation

alone can solve. Nevertheless, it seems to me there is opportunity, and a rather major one, to provide some form of central national resource to the many municipal, local, State, and regional entities which are trying at their level to cope with these problems and which have neither the resources, the training, the knowledge, or the connectedness to allow them to do it properly

It seems to me there is one place where there is room for effective national assistance.

Secondly, it seems to me there is an urgent need for the development of performance criteria for public systems. This phrase is much more easily said than it is implemented. In fact, most of our standards in all of the public sector areas we have talked about are not based on performance criteria, but on materials design specifications.

We, in general, tend not to have performance criteria for what a transportation system or vehicle must do. Our standards refer to what it should be made up and what its design and measurements should be. Part of the reason for that is the technical difficulty for stating the performance. This is the major technical problem. It is particularly a problem at the high level we are talking about.

We were talking about systems, the problem of development of performance criteria for the Minuteman missile is a major development. San Diego's transportation system is a far more technical problem. It seems to me here this is one area in which Government participation makes excellent sense. This is not an area in which Government can be accused of competing unfairly with private industry; it rather is a technical concern which will help to set the framework for what private companies can do. It would, on the contrary, have the effect of creating easier entry into markets which are now foreclosed.

The National Bureau of Standards represents one major Federal resource for the development of performance criteria in public systems fields. It has received relatively little attention or support from the Congress, given its national importance. New attention and support is very much within the scope of interest of this committee.

Third, the Federal Government disposes of enormous purchasing power in many areas, that is, building and construction, hospital and health facilities, and waste disposal systems. There is need for a variety of instances to provide demonstration or models of the opening up of markets based on performance criteria for new systems solutions.

The Federal Government could itself model the kinds of systems approach as a consumer, which is being advocated here. While some starts along this line have been made, particularly in the military and aerospace fields, relatively little has been done in civilian areas.

Small beginnings have been made with military housing requirements and with the building and construction needs of the General Services Administration. The broad-scale use of Federal purchasing power as a modeling vehicle and as an incentive to broader civilian actions along the same line will be of great importance.

If the Federal Government as a consumer used the same criteria for procurement that we are asking clients on the State and regional level to use in order to stimulate systems approaches to the solution of those

problems, they could provide a major model and demonstration of the process which we are here trying to encourage.

Two other items which are not in the written testimony, but which I would like to add, are these. A number of university programs are now beginning to address themselves toward the kinds of systems skills which are required not only to do the technical job of analysis, but also to deal with the problems of social innovations which are so critical to its success.

To my knowledge programs are underway at three universities. They are also a large part of programs of new universities which are being planned, for example, in Nassau County in New York State, to support the development of trained skillful people in these areas would be one useful contribution.

Furthermore, if the systems approach as we have been discussing it, is to be effective at State, regional, and local levels, there must be at those levels clients who are prepared to understand it. If funds are provided for it or legislation is in being which requires it and yet the client systems, the people who buy it, are not equipped to deal with it, to buy it effectively, it is not going to be successful.

So, it seems to me there should be as part of an overall approach to this problem an effort made to provide funds for the training and development of knowledgeable, professional, skillful clients for systems approach solutions to problems at the community, State, and regional levels.

Senator, that concludes the prepared testimony.

Senator NELSON. Thank you very much, Dr. Schon. It was a fine presentation.

Have you had a chance to examine the two pending bills carefully?

Dr. SCHON. Only schematically, not in detail.

Senator NELSON. Do you have any ideas or suggestions you would make in the preparation of legislation to accomplish the purpose that these bills seek to accomplish?

Our objective is to encourage the—several objectives, one of them is to encourage the use of the concept of systems analysis, which can be rather simply done by giving the 701 grants, but that is probably not the best way.

I am also interested in using the technique on a regional basis.

You could set up a series of regional systems, engineering groups maybe, that would have available consultants to regional planning commissions, to cities, States, and so forth. I do not know whether that would work or whether it is a good approach, but I am wondering if you would have some suggestions about what you would do if you were drafting the legislation in order to best implement the objectives that we seek to accomplish.

Dr. SCHON. I have a couple of comments that come to mind. Whether they make sense in terms of the real problems of drafting legislation, I am not sure.

One is this: That characteristically in this business there is an almost absurd discrepancy between the sophistication of the material that is

offered and the ability of the client to use it. So that any amount of consulting resource provided to State and local and regional groups or governments which are not prepared for this, either because they are shorthanded or because the level of person who is buying simply is not trained to understand what it is he is buying, will lead to the failure of the approach.

What we will have proved is, it was invested in by people who were not prepared to use it. So there should be the education of the clients who are going to use it.

Now, how to do this training? Supplementary grants to enable State and municipal governments to hire sorts of persons who will be able to purchase intelligently systems analyses, systems engineering jobs. This may be one approach.

The development of regional institutes to which city governments, State governments could send members of their administrative staffs in order to work with consultants, not to solve specific problems but to learn the skills which will later be involved in buying intelligently. These will help substantially.

I do know—and I think Dr. Kimball might agree from his industrial experience—that everything will depend on the receptivity of the people who are going to buy. The consultant stops at the point where he hands his plan on to the person who purchases the plan.

This is one comment.

The other comment is that it seems to me it's very difficult to think about how you change something as complicated as the United States from some central point like its Congress, what you are really trying to do is propagate a frame of mind throughout the country. You are trying to develop a frame of mind that is conducive to tackling the community problems in a system-oriented way.

You are wanting to persuade. Now, one strategy for doing this is to see a central pot of money fanned pretty much homogeneously across the States. Another approach to it is an approach which would identify a relatively small but important and highly publicized number of instances chosen because they make such good demonstrations of what is being proposed.

It seems to me the thought might be given within the bill to the setting up of a relatively small number of demonstration projects which might be chosen across the spectrum of public systems needs—community improvement, low-cost housing, urban transportation, the administration of State government itself, for example, which could be developed as demonstration centers. And then provide vehicles for the training of others.

I guess what I am getting at here is that the resources of skilled persons able to do what we are talking about are much smaller than we ordinarily think they are. There are not large hordes of people who are skilled in doing systems analysis in civilian areas. They are relatively small numbers who are. There are many more who have the potential for doing so if they were able to learn certain other things.

It seems to me that a program which would at least include in its

beginning a relatively small number of demonstration instances, part of whose function would be teaching and training, would in some ways be a more intelligent program.

Senator NELSON. You observed that it is difficult to educate people in large countries, the United States. I might point out that part of the objective of the bill is to educate the Federal bureaucracy, too, since there are a number of national problems which should be approached in this fashion which are handled in a thousand piecemeal ways.

Thank you very much. We will give the reporter a 5-minute break and we will resume with Paul Grogan, Director; Martin Robbins, Assistant Director, for the Special Programs Office of the State Technical Services of the Department of Commerce.

(Whereupon, a brief recess was taken.)

Senator NELSON. We will resume hearings at this time. I am glad to welcome Mr. Paul Grogan who, as I said, is Director, and Martin Robbins, Assistant Director for Special Programs, Office of State Technical Services of the Department of Commerce.

We will be glad to hear Dr. Grogan. He was a former professor of engineering at the University of Wisconsin. We are glad to have you here to present your testimony.

Do you have a prepared text that will be printed in full in the record? You may read it or extemporize, however you wish to proceed.

STATEMENT OF PAUL GROGAN, DIRECTOR, OFFICE OF STATE TECHNICAL SERVICES, DEPARTMENT OF COMMERCE, ACCOMPANIED BY MARTIN ROBBINS, ASSISTANT DIRECTOR FOR SPECIAL PROGRAMS

Mr. GROGAN. Thank you, Mr. Chairman, I will use it to guide my remarks and try to tighten it up in the interest of time.

I appreciate your reference to Wisconsin. I have a word or two to say about that in the course of any remarks.

We are pleased to have this opportunity to appear before the Special Subcommittee on Scientific Manpower Utilization of the Senate Committe on Labor and Public Welfare to present some of the experiences and examples in ongoing programs under the State Technical Services Act of 1965 that we believe relate to the subject of your hearings.

The Office we represent was established November 19, 1965, to administer the State Technical Services Act of 1965. The association of Mr. Robbins and myself with this work therefore has been correspondingly brief. However, we believe that our experience in the field of State technical services is pertinent to your deliberations.

In addition, Mr. Robbins' immediate previous assignment was with the Denver Research Institute, one of those nonprofit organizations Dr. Kimball referred to, where he gained an appreciation of the in-

terplay between technological and sociological forces that seem increasingly to dominate our life and times.

I have only recently interrupted a 15-year association in university extension at the University of Wisconsin, where, as you well know, Mr. Chairman, they practice daily the involvement of a major institution of higher learning with the total environment of the State.

In the interest of your time and to avoid possible duplication with what already has been said, we will attempt to confine our remarks to experiences in administering the State Technical Services Act.

First, a few words about the structure and purposes of the Office of State Technical Services.

The Office was established to deal with many of the scientific and technical needs of American business and industry.

In particular, we are concerned with the ability of industry to acquire and apply new technology. The basis for this concern is the relationship between the rate of application of new technology by industry and the overall economic growth of the Nation.

This sense of mission with respect to the application of new science and technology in the civilian sector of our economy has taken on a new urgency in recent years. Certain segments of the economy, particularly those related to military preparedness, space exploration, and atomic energy, have forged ahead of the civilian sector of the economy in terms of the generation and application of new knowledge.

Correspondingly slower growth and expansion by other segments of American business has resulted in a number of problems and imbalances having a generally unfavorable effect on the national economy. Major program concerns resulting from these imbalances fall into five general categroies:

We see technological change as causing unfavorable imbalances in our economy. Individuals, companies, metropolitan complexes, States, and regions share unequally in the benefits to be gained from the acquisition and application of new technology.

This is demonstrated by the uneven concentration of scientific, technological, managerial, and financial resources between potentially similar regions, industries, and educational institutions.

Traditional practices and policies with respect to the national research and development effort tend to accentuate this condition.

2. Technological change has caused obsolescence among men and machines: Technological obsolescence and pockets of unemployment develop into major problems as individual job skills and whole segments of industry can no longer compete effectively in the American economy.

Scientists, engineers, technicians, and craftsmen must acquire and practice the new knowledge in their respective fields or face obsolescence.

The same threat applies to organizations and machines that are not adapted to changes in technology. Programs addressed to this prob-

lem, to date, have not realized the full potential of transferring advanced technological practices and skills to the improvement of organizations and people.

3. Technological change has become an economic determinant in our society: The general prosperity of this country depends, in large measure, upon the ability of industry to apply new technology.

Industry has not always directed a sufficient measure of its resources toward developing new technology, nor has it taken full advantage of the technology derived from Government-supported research.

The more broad application of new technology by industry should result in higher profits, greater productivity, increased employment, new products, and general local and regional prosperity.

4. Technological change abroad has increased foreign competition: As foreign industry becomes more selective in the application of new technology to produce goods used in the civilian economy, competition becomes more intense and displaces American goods, jobs, and business opportunities.

Comparable emphasis is lacking in this country with respect to the use of advanced technology to produce goods for consumer markets at home and abroad.

5. Technological change has impaired some aspects of the quality of life: The bright promise of the 20th century begins to pale for want of solution to the problems of urban sprawl and central-city slums; of wasted water resources and polluted air; of freeways that destroy sense of neighborhood while failing to solve traffic problems; of great expenditures and advances in education while culture and personal integrity are often said to be lacking; of social and economic pressures inducing more and more people to take up living in large cities where menaces to public health and safety more often abound.

The State Technical Services Act of 1965 applies to the 50 States, the District of Columbia, Guam, Puerto Rico, and the Virgin Islands.

The planning process required by the act before engaging in technical services began almost immediately and universally a year ago.

We now have, in other words, 53 political entities engaged in the planning process and 42 States have prepared and submitted State technical services programs for our review.

The State Technical Services Act calls for a designated agency in each State, appointed by the Governor, to administer and coordinate the technical services programs of that State. The gubernatorial designations are nearly equally divided between State agencies responsible for economic development and State universities.

We note, Mr. Chairman, that the proposed legislation on the utilization of scientific manpower makes reference to a similar State-designated agency or office.

The subcommittee may find of interest this list of designated agencies and principal personnel contacts by States who administer and coordinate the STS programs. We offer this information for the record.

(The document referred to follows:)

U.S. Department of Commerce, Office of State Technical Services

State designated agencies

State	Designated agency and official	Working contact
Alabama	Dr. Wilford S. Bailey, director of research, Auburn University, Auburn, Ala.	Dr. Wilford S. Bailey, director of research, Auburn University, Auburn, Ala.
Alaska	Mr. William M. Dickson, commissioner, department of economic development and planning, Post Office Box 1421, Juneau, Alaska.	Mr. William M. Dickson, commissioner, department of economic development and planning, Post Office Box 1421, Juneau, Alaska.
Arizona	Dr. F. Pendleton Gaines, dean of continuing education, University of Arizona, Tucson, Ariz.	Dr. Benjamin S. Mesick, professor of mechanical engineering, office of continuing education, University of Arizona, Tucson, Ariz.
Arkansas	Dr. Barton A. Westerlund, director, Industrial Research and Extension Center, University of Arkansas, Technology Campus, Post Office Box 3017, Little Rock, Ark.	Mr. Daniel B. Howard, manager, business and technical services, Industrial Research and Extension Center, University of Arkansas, Post Office Box 3017, Little Rock, Ark.
California	President Clark Kerr, University of California, Berkeley, Calif.	Dean Robert L. Wiegel, director, State technical services, 714 University Hall, University of California, Berkeley, Calif.
Colorado	Mr. Dwight E. Neill, director, division of commerce and development, 600 State Services Building, Denver, Colo.	Mr. Dwight E. Neill, director, division of commerce and development, 600 State Services Building, Denver, Colo.
Connecticut	Mr. Harold F. Heintz, executive secretary, Connecticut Research Commission, room 411, State Capitol Building, Hartford, Conn.	Mr. Harold F. Heintz, executive secretary, Connecticut Research Commission, room 411, State Capitol Building, Hartford, Conn.
Delaware	Mr. George M. Worrilow, vice president, division of urban affairs, University of Delaware, Newark, Del.	Mr. Robert W. Cook, director, technology and business services, University of Delaware, Newark, Del.
District of Columbia	Most Reverend Edward B. Bunn, chairman, Consortium of Universities of the Washington Metropolitan Area, 1903 N St. NW., Washington, D.C.	Dr. Elmer West, executive secretary, Consortium of University of the Washington Metropolitan Area, 1903 N St. NW., Washington, D.C.
Florida	Dr. J. B. Culpepper, chancellor, board of regents, office for continuing education, Box 1562, Tallahassee, Fla.	Dr. Robert W. Long, State coordinator, Post Office Box 1562, Tallahassee, Fla.
Georgia	Dr. George L. Simpson, Jr., chancellor, board of regents of the University System of Georgia, 244 Washington St., Atlanta, Ga.	Mr. Alton J. Jenson, senior research engineer, Rich Electronic Computer Center, Georgia Institute of Technology, Atlanta, Ga.
Hawaii	Dr. Shelley M. Mark, director, department of planning and economic development, 426 Queen St., Honolulu, Hawaii.	Col. Wilbur W. Hurt, research and development coordinator, department of planning and economic development, 426 Queen St., Honolulu, Hawaii.
Idaho	Miss Louise Shadduck, executive secretary, Idaho Department of Commerce and Development, State Capitol Building, Boise, Idaho.	Mr. Lloyd Howe, economic analyst, State of Idaho Department of Commerce and Development, State Capitol Building, Boise, Idaho.
Illinois	Mr. Gene Graves, director, department of business and economic development, Springfield, Ill.	Dr. Louis A. Volpp, associate provost, University of Illinois, Urbana, Ill.
Indiana	Hon. Roger D. Branigin, Governor of Indiana, Indianapolis, Ind.	Hon. Roger D. Branigin, Governor of Indiana, Indianapolis, Ind.
Iowa	Mr. Stanley Redeker, president, State board of regents, State Office Building, Des Moines, Iowa.	Mr. Waldo W. Wegner, director, Center for Industrial Research and Service, 201 Building E, Iowa State University, Ames, Iowa.
Kansas	Dr. Christopher E. Barthel, Jr., executive director, Research Foundation of Kansas, Topeka, Kans.	Mr. Kenneth Razak, associate dean of engineering, Research Foundation of Kansas, Topeka, Kans.
Kentucky	Miss Katherine Peden, commissioner, Kentucky Department of Commerce, Frankfort, Ky.	Mr. Damon W. Harrison, executive assistant, Kentucky Department of Commerce, Bush Building, Frankfort, Ky.
Louisiana	Mr. William T. Hackett, Jr., executive director, Louisiana Department of Commerce and Industry, Post Office Box 4185, Capitol Station, Baton Rouge, La.	Mr. Gene Wallace, economic development specialist, Post Office Box 4185, Capitol Station, Baton Rouge, La.
Maine	Dean Thomas H. Curry, department of industrial cooperation, Boardman Hall, University of Maine, Orono, Maine.	Mr. F. Philip Dufour, coordinator, STS program, department of industrial cooperation, Boardman Hall, University of Maine, Orono, Maine.

U.S. Department of Commerce, Office of State Technical Services—Con.

State designated agencies—Continued

State	Designated agency and official	Working contact
Maryland	Mr. George W. Hubley, Jr., director, Maryland Department of Economic Development, State Office Building, Annapolis, Md.	Mr. John Hosford, chief, economic research, Maryland Department of Economic Development, State Office Building, Annapolis, Md.
Massachusetts	Hon. John A. Volpe, Governor of Massachusetts, Boston, Mass.	Dr. Howard D. Segool, director, Massachusetts Technical Resource Service, Commonwealth of Massachusetts School of Engineering, University of Massachusetts, Amherst, Mass.
Michigan	Mr. Robert J. McIntosh, director, department of commerce, Lansing, Mich.	Mr. David M. Poxson, industrial agent, Michigan Department of Economic Expansion, Stevens T. Mason Building, Lansing, Mich.
Minnesota	Mr. Ray Lappegaard, commissioner of administration, 120 State Capitol, St. Paul, Minn.	Mr. Ray Lappegaard, commissioner of administration, 120 State Capitol, St. Paul, Minn.
Mississippi	Dr. Kenneth C. Wagner, director, Mississippi Research and Development Center, Post Office Box 2470, Jackson, Miss.	Dr. Kenneth C. Wagner, director, Mississippi Research and Development Center, Post Office Box 2470, Jackson, Miss.
Missouri	Mr. Henry C. Maddox, director, division of commerce and industrial development, Jefferson Building, Jefferson City, Mo.	Mr. Michael Corcoran, acting director, State technical services, 130 Engineering Building, University of Missouri, Columbia, Mo.
Montana	Dr. Norman E. Taylor, director, bureau of business and economic research, University of Montana, Missoula, Mont.	Dr. Norman E. Taylor, director, bureau of business and economic research, University of Montana, Missoula, Mont.
Nebraska	Dean E. W. Janike, extension division, 205 Nebraska Center for Continuing Education, University of Nebraska, Lincoln, Nebr.	Dr. George Shrader, director, State technical services, 205–C Nebraska Center for Continuing Education, University of Nebraska, Lincoln, Nebr.
Nevada	President Charles J. Armstrong, University of Nevada, University Station Post Office, Reno, Nev.	Mr. Robert B. McKee, Jr., director, State technical services, University of Nevada, Reno, Nev.
New Hampshire	Hon. John W. King, Governor of New Hampshire, Concord, N.H.	Dr. Robert N. Faiman, dean, College of Technology, University of New Hampshire, Durham, N.H.
New Jersey	Commissioner Robert A. Roe, department of conservation and economic development, Trenton, N.J.	Mr. Howard L. Wolf, special assistant to the commissioner, department of conservation and economic development, Trenton, N.J.
New Mexico	President T. L. Popejoy, University of New Mexico, 1821 Roma Ave. NE., Albuquerque, N. Mex.	Mr. Arthur A. Blumenfeld, director, bureau of business research, 1821 Roma Ave. NE., Albuquerque, N. Mex.
New York	Commissioner Keith S. McHugh, Department of Commerce, 112 State St., Albany, N.Y.	Mr. Robert W. Larson, consultant, New York Department of Commerce, 112 State St., Albany, N.Y.
North Carolina	Mr. E. L. Rankin, Jr., director, State department of administration, Post Office Box 1351, Raleigh, N.C.	Dr. William L. Turner, dean of university extension, Holladay Hall, North Carolina State University, Raleigh, N.C.
North Dakota	Mr. Fred Brandt, executive director, North Dakota State Planning Agency, State Capitol Building, Bismarck, N.Dak.	Mr. Loren Stadig, economist, North Dakota State Planning Agency, State Capitol Building, Bismarck, N. Dak.
Ohio	Dr. John D. Millett, director, Ohio Board of Regents, 88 East Broad St., Columbus, Ohio.	Mr. James M. Furman, executive officer Ohio Board of Regents, 88 East Broad St., Columbus, Ohio.
Oklahoma	President Oliver S. Willham, Oklahoma State University, Stillwater, Okla.	Dr. J. C. Evans, dean, university extension, Oklahoma State University, Box 1008, Stillwater, Okla.
Oregon	Mr. Samuel Mallicoat, administrator, division of planning and development, 560 State Office Building, Portland, Oreg.	T. G. La Follette, consultant, technical services, Commerce Building, 158 12th St. NE., Salem, Oreg.
Pennsylvania	Dr. Eric A. Walker, president, Pennsylvania State University, University Park, Pa.	Dr. H. Leroy Marlow, director, PENNTAP, Pennsylvania State University, University Park, Pa.
Puerto Rico	Mr. Raphael Durand, administrator, Commonwealth economic development administration, San Juan, P.R.	Mr. Gerardo E. Maldonado, coordinator, office of technical services, Commonwealth economic development administration, San Juan, P.R.
Rhode Island	Hon. John H. Chafee, Governor of Rhode Island, Providence, R.I.	Mr. James W. Norman, c/o Bliss Hall, University of Rhode Island, Kingston, R.I.

U.S. DEPARTMENT OF COMMERCE, OFFICE OF STATE TECHNICAL SERVICES—Con.

State designated agencies—Continued

State	Designated agency and official	Working contact
South Carolina	Dr. Henry C. Schultze, director, Development Research Center, State development board, Post Office Box 927, Columbia, S.C.	Mr. A. Cartwright Hart, administrator, technical services program, State development board, Post Office Box 927, Columbia, S.C.
South Dakota	Mr. Francis Chichester, acting director, State planning agency, State Capitol, Pierre, S. Dak.	Mr. Francis Chichester, acting director, State planning agency, State Capitol, Pierre, S. Dak.
Tennessee	Mr. Robert S. Hutchison, executive director, Government Industry Law Center, University of Tennessee, 1000 White Ave., Knoxville, Tenn.	Mr. Reuben E. Harris, director, Tennessee Industrial Research Advisory Service, 810 Broadway, room 200, Nashville, Tenn.
Texas	Dr. Lester E. Harrell, Jr., acting commissioner of higher education, coordinating board, Texas College and University System, Sam Houston State Office Building, Austin, Tex.	Mr. Joe W. Tyson, director, State technical services program, coordinating board, Texas College and University System, Sam Houston State Office Building, Austin, Tex.
Utah	Mr. L. Ralph Mecham, assistant to the president for special projects, University of Utah, 210 Park Building, Salt Lake City, Utah.	Mr. Gene Hansen, assistant director, State technical services, University of Utah, Salt Lake City, Utah.
Vermont	Hon. Philip H. Hoff, Governor of Vermont, Montpelier, Vt.	Mr. David C. Emery, coordinator, State technical services, industrial division, Vermont Development Department, Montpelier, Vt.
Virginia	President T. Marshall Hahn, Jr., Virginia Polytechnic Institute, Blacksburg, Va.	Dr. Roger L. Smith, planning director, State technical services, Virginia Polytechnic Institute, Blacksburg, Va.
Virgin Islands	President Lawrence C. Wanlass, College of the Virgin Islands, St. Thomas, V.I.	Mr. Walter M. Taylor, project director, State Technical Services Act, College of the Virgin Islands, Box 1826, St. Thomas, V.I.
Washington	Mr. Daniel B. Ward, director, State Washington Department of Commerce and Economic Development, Olympia, Wash.	Mr. Kennard Weddell, coordinator, Washington State technical services, department of commerce and economic development, Olympia, Wash.
West Virginia	Mr. Angus E. Peyton, commissioner, West Virginia Department of Commerce, State Capitol, Charleston, W. Va.	Mr. Allen T. Peyton, Jr., technical services coordinator, industrial development division, State Capitol, Charleston, W. Va.
Wisconsin	Professor George Strother, University of Wisconsin, 432 North Lake St., Madison, Wis.	Dr. Gregory Hedden, director, STS program, University of Wisconsin, Extension Building, room 301, 432 North Lake St., Madison, Wis.
Wyoming	Dr. Dwight M. Blood, director, division of business and economic research, Box 3275, University Station, University of Wyoming, Laramie, Wyo.	Dr. Dwight M. Blood, director, division of business and economic research, Box 3275, University Station, University of Wyoming, Laramie, Wyo.

Mr. GROGAN. The State Technical Services Act also calls for the appointment of an advisory council that is representative of broad community interests.

This council reviews, evaluates, and reports on proposed STS programs to the Governor and to our Office. Over 600 representatives of the business and industrial community are presently serving in this capacity.

When all of the advisory councils have been constituted throughout the Nation, this number is expected to reach 800. This commitment by the States, along with the full-time designated agency personnel and the matching financial support from non-Federal sources, offer eloquent testimony to local leadership, initiative, participation, and resources being brought to bear on the objectives of this act.

I believe the planning process, which all of the States must carry out to participate in State Technical Services Act programs, will be of interest to the subcommittee.

The State Technical Services Act requires that the State-designated agency prepare a 5-year plan that outlines the technological and

economic conditions of the State. The problem areas identified in the 5-year plans reviewed to date describe a wide range of conditions existing at present among the States.

These conditions tend to cluster around four main categories:

1. Existing industries fail to apply modern methods.
2. Shortages of experienced managers and qualified technical personnel.
3. Economy in transition is seen as unfavorably influencing economic growth and development.
4. Location, resource, and climate factors seen as limiting development.

These main points have been broken down into some 20 subtopics and they are submitted for the record.

(The information referred to follows:)

MAJOR STATE PROBLEMS AS EXPRESSED IN 5-YEAR PLANS

1. Existing local industries fail to apply modern methods.
   - *a.* Lack of information about modern technology.
   - *b.* Lack of know-how in applying technological information.
   - *c.* Services needed in support of service-oriented industry.
   - *d.* Resistance to change by some businessmen.
   - *e.* Shortage of investment capital.
   - *f.* Obsolete equipment and physical plant.
2. Shortage of experienced managers and qualified technical personnel.
   - *a.* Few academic, governmental and industrial research facilities in State.
   - *b.* Young people leaving State after completing education.
   - *c.* Lack of continuing educational facilities to up-date graduate engineers.
   - *d.* Spirit of entrepreneurship often lacking.
3. Economy in transition unfavorably influencing growth and development.
   - *a.* Need for new industry and greater industrial diversification.
   - *b.* Declining agriculture has placed burden of employment upon growth.
   - *c.* Cyclical swings in manufacturing.
   - *d.* Technological changes reducing employment in major industries.
   - *e.* Pockets of poverty in some areas of State.
   - *f.* Problems of urbanization.
4. Location, resource and climate factors seen as limiting development.
   - *a.* Major dependence on a few resource-based industries with high seasonal fluctuations in employment, for example, agriculture, lumber, construction, tourist trade and mining.
   - *b.* Natural resources and partially processed products being shipped to other states to be transformed into consumer goods.
   - *c.* Physical conditions in State impede industrialization, for example, severe winters and mountainous topography.
   - *d.* Sparsity of population and distance from major markets, resulting in unfavorable freight-rates as a shore of cost of both imported and exported materials and goods.

Mr. GROGAN. There are many ways in which the individual States have approached planning for technical services. Some have integrated such planning into a systems concept of economic development for the State.

By the way, we are pleased with the definitions of systems analysis given by Dr. Kimball and Dr. Schon.

The 5-year plan from Nebraska, for example, envisages combining several factors—research, technical services, community services, and promotion—public education—with adequate systems management to reach the common objective of economic development.

The 5-year plan for Massachusetts, on the other hand, contemplates a more elaborate systems approach in performing technical services on behalf of the economy of the Commonwealth.

This plan discusses (1) activity centers, (2) consultative services, (3) informational services, (4) educational services, (5) liaison services, and (6) referral services.

The Massachusetts plan has the further attribute of being coordinated with the potential regional plan for the New England area.

The example of regional planning in New England is but one instance in which the States are beginning to realize that their economy is closely linked into the economic system of the region.

The New England States realized their interdependency long ago and are now engaged in regional planning for participation under this act.

Other regions are beginning to look at this approach to their economic development, as in the examples of the Rocky Mountain States, the Gulf Coast States, and the Pacific Northwest.

While the processes at work in these several examples are very rudimentary in terms of sophisticated thinking about systems, they still represent significant and imaginative undertakings in this new program. They demonstrate a genuine understanding of the need for overall systems planning.

The technical services supported by Federal matching grants are performed by "qualified institutions," which are colleges and universities with accredited programs in engineering, science, or business administration.

Other educational institutions, State agencies, and nonprofit organizations may be deemed "qualified" if they meet certain criteria. More than 100 qualified institutions participated in the 24 State programs approved in 1966.

I think this is interesting; it figures out to be an average of four institutions per State. Potentially, this number might grow as the State programs take on more ambitious activities.

Virtually all of these were the major universities and colleges within their respective States.

We have a tabulation, Mr. Chairman, of institutions participating by States among the 24 programs approved in fiscal year 1966.

This information, which might be of interest to you, is available for the record.

Senator NELSON. That will be included at this point.

(The information referred to follows:)

PARTICIPATION IN STATE TECHNICAL SERVICES GRANTS AND PROGRAMS—OFFICES, AGENCIES, AND INSTITUTIONS, BY STATES, FISCAL YEAR 1966

Alabama: Auburn University
Alaska: Dept. of Economic Development
Arizona: University of Arizona
Arkansas: University of Arkansas
California:
- University of Calif. at Berkeley
- California State Library
- Humboldt State College
- Univ. of California at L.A.

Colorado: Div. of Commerce and Development
Connecticut: Connecticut Research Commission
Delaware: University of Delaware
District of Columbia: Consortium of Universities of the Washington Metropolitan Area
Florida:
- Board of Regents
- Brevard Engineering College
- Florida A&M University
- Florida State University
- University of Florida

Georgia:
- Board of Regents
- Georgia Institute of Technology
- Savannah State College
- University of Georgia
- West Georgia College

Hawaii: Department of Planning and Economic Development
Idaho: Department of Commerce and Development

PARTICIPATION IN STATE TECHNICAL SERVICES GRANTS AND PROGRAMS—Continued

Illinois:
- Department of Business and Economic Development
- IIT Research Institute
- University of Illinois
- Southern Illinois University

Indiana: Office of Governor

Iowa:
- Board of Regents
- Buena Vista College
- Clarke College
- Drake University
- Iowa State University
- Morningside College
- State University of Iowa

Kansas:
- Kansas State University
- University of Kansas
- Wichita State University
- Research Foundation of Kansas

Kentucky: Kentucky Department of Commerce

Louisiana:
- Department of Commerce and Industry
- Gulf South Research Institute
- Louisiana Polytechnic Institute
- Loyola University

Maine: University of Maine

Maryland: Maryland Department of Economic Development

Massachusetts: Office of the Governor

Michigan:
- Department of Commerce
- Central Michigan University
- Eastern Michigan University
- Ferris State College
- Grand Valley State College
- Michigan State University
- Michigan Technological University
- Northern Michigan University
- University of Michigan
- Wayne State University
- Western Michigan University

Minnesota:
- Department of Administration
- Department of Business Development
- St. Olaf College
- University of Minnesota

Mississippi: Mississippi Research and Development Center

Missouri:
- Department of Commerce and Industrial Development
- St. Louis University
- University of Missouri
- Washington University

Montana: University of Montana

Nebraska: University of Nebraska

Nevada: University of Nevada

New Hampshire: Office of the Governor

New Jersey:
- Department of Commerce and Economic Development
- Stevens Institute of Technology

New Mexico: University of New Mexico

New York:
- Cornell University
- Department of Commerce
- Fordham University
- Manhattan College
- New York University
- Polytechnic Institute of Brooklyn
- Pratt Institute
- Rensselaer Polytechnic Institute
- Rochester Institute of Technology
- St. Lawrence University
- State University of New York at:
  - Alfred University
  - Buffalo
  - Stony Brook
- Syracuse University
- University of Rochester
- Western New York Nuclear Research Center, Inc.

North Carolina:
- Department of Administration
- North Carolina State University
- Wake Forest College

North Dakota:
- North Dakota State Planning Agency
- Minot State College
- North Dakota State University
- University of North Dakota

Ohio: Board of Regents

Oklahoma:
- Oklahoma State University
- Lampton University
- Oklahoma City University
- Southeastern State College
- Southwestern State College
- University of Oklahoma
- University of Tulsa

Oregon: Bureau of Planning and Development

Pennsylvania:
- Graphic Arts Technical Foundation
- Franklin Institute
- Pennsylvania College of Textiles and Sciences
- The Pennsylvania State University
- University of Pittsburgh

Puerto Rico: Economic Development Administration

Rhode Island: Office of the Governor

South Carolina: State Development Board

South Dakota: State Planning Agency

Tennessee:
- University of Tennessee
- Christian Brothers College
- East Tennessee State University
- Middle Tennessee State University
- University of Chattanooga
- Vanderbilt University
- Tennessee Technological University

Texas:
- Texas College and University System
- Southern Methodist University
- Texas A&M University
- Texas Women's University
- University of Texas

Utah: University of Utah
Vermont: Office of the Governor
Virginia: The Virginia Polytechnic Institute
Virgin Islands:
- College of the V.I., St. Thomas
- College of the V.I., St. Croix

Washington:
- Department of Commerce and Economic Development
- Eastern Washington State University
- Gonzaga University
- Pacific Lutheran University
- University of Washington

West Virginia: Department of Commerce
Wisconsin:
- University of Wisconsin, Madison
- University of Wisconsin, Milwaukee
- University of Wisconsin, Wausaw

Wyoming: University of Wyoming

Mr. GROGAN. The "Technical Services" under the act consist of information centers, referral centers, field visits, demonstrations and educational programs in a variety of formats. Nearly 600 separately identifiable activities were supported in 24 State programs in fiscal year 1966.

These services range from continuous programs run by a full-time professional staff to one-time conferences or short courses. These services are in progress all across the country. Several representative examples include:

1. Michigan: A program at Ann Arbor, May 24, 1966, on how to apply computer technology in business was attended by more than 200 businessmen. In another pair of programs on the numerical control of machine tools, 69 participated at Ann Arbor and 44 at Traverse City.

2. Wisconsin: The State technical services program in Wisconsin is sponsoring a series of conferences around the State in which the applications and the economic benefits to be derived from new technologies, such as fluid power, adhesives, welding, powder metallurgy, metal forming and cutting (removal) and computer applications in industry are presented in such a way that the top manager has a better basis for judging the relevance of the new technology to his company products or processes.

The most recent STS newsletter from Wisconsin lists more than 30 engineering short courses in Madison and Milwaukee the first 3 months of this year. Topics include: Computer-aided solid circuit design, manufacturing cost analysis, critical path method, adhesives for wood and paper, adhesives for metal and plastics, matrix methods of structural analysis and nondestructive testing techniques.

3. In Iowa, where there is more of a plastics industry than people realize, they ran a course on plastics for 2 days, attended by nearly 100 persons. An industrial engineering workshop at Ames was attended by more than 80 persons.

4. Illinois: The Illinois Institute of Technology Research Institute has designed a series of 1-day seminars on numerical control techniques aimed at the needs of small- and medium-sized "tool and die shop" type operations. Firms wishing to go deeper into the subject may then engage in a practical working experience in the application of numerical control to various manufacturing processes.

5. New York: Syracuse University is operating a technical information service sensitive to the scientific and technical needs of central New York business, commerce, and industry. Interest profiles of local industry have been compiled, with inventories of technical information resources established and made available to industrial users.

6. Texas: Conference and workshop activities served a total of 100 persons in the three specialized areas of professional engineering, production management and nondestructive testing techniques using neutron activation analysis.

The second annual technical services program was recently submitted by the State of Michigan. The designated agency in Michigan is the Department of Commerce, with specific responsibility for administering the program delegated to their Office of Economic Expansion.

Michigan institutions will participate in the program as follows:

1. Ferris State College.
2. Western Michigan University.
3. Grand Valley State College.
4. Northern Michigan University.
5. Michigan Technological University.
6. Eastern Michigan University.
7. The University of Michigan.
8. Central Michigan University.
9. Michigan State University.
10. Wayne State University.
11. Saginaw Valley College.

The first priority set by Michigan is the development of a statewide system for coordination and information interchange.

They are carrying this out by establishing a network of technical services directors at each of the participating institutions and an overall statewide systems manager.

The Michigan people rightly understand the complexity of the task of transferring technology to industry. This complexity, they believe, is due to the staggering range of skills needed to deal with all of the scientific and technical disciplines which are needed by Michigan industry.

No one individual can presume to have competence in all fields for purposes of effecting meaningful technology transfer to large numbers of Michigan firms. However, an individual can serve as a fulcrum around which such transfer takes place. This individual in the Michigan plan is the initial contact point through which the firms in his area are connected to the appropriate technological resources.

Each participating institution in Michigan has been assigned a

State technical services program director. These directors are the link between industry and the statewide system which contains the reservoir of technical expertise.

Through this arrangement, the various institutions provide Michigan industry with rapid access to applicable technology, including a statewide information retrieval and dissemination system. They believe in Michigan that this system will provide the leverage to effect exchanges of large quantities of technology over a wide geographic area and among highly diverse industrial firms at a fraction of the unit cost of any other method.

The Michigan program also calls for each of the participating institutions to conduct seminars, workshops, and demonstrations of new technology. They believe this approach provides an effective means for limited transfer of technology. By "limited," they mean that such transfer mechanisms are by nature more general than specific. They stimulate awareness and prepare large numbers of people at low costs for specific transfers. Within that framework, they are a major part of Michigan's plan.

Seminars, workshops, and demonstrations that will be conducted in Michigan fall into three general categories:

1. Industry and commercial techniques.
2. Advanced management practices.
3. Technology transfer techniques.

Seminars will be run under these categories on such diverse subjects as plastics technology, metallurgy of new materials and their tooling requirements, tungsten inert gas welding techniques, neutron activation analysis, numerical control, new product development, and innovation and technology transfer.

To describe typical State programs and some of the specific areas of technological served, we have available a special issue of the State Technical Services Newsletter. This newsletter includes a sampling of technical services activities approved by our office last year. We offer it for the record.

(The newsletter follows:)

STATE TECHNICAL SERVICES NEWSLETTER—U.S. DEPARTMENT OF COMMERCE—OFFICE OF STATE TECHNICAL SERVICES, NOVEMBER 1966

REPRESENTATIVE ACTIVITIES APPROVED IN FISCAL YEAR 1966

This issue is given over entirely to describing representative activities of the nearly 600 technical services incorporated in the 24 State Programs approved in Fiscal Year 1966. The activities described here were selected on the basis of their representativeness in the following categories of technical services: information dissemination, referral services, field services and industrial liaison, directed news of STS activities in States, courses in information dissemination, use of educational TV, courses in use of computers in business, and courses in specialized technology.

Each entry under the above categories includes a title and brief description of the activity and the name and location of the participating institution responsible for the conduct of the technical services. Information about the listed activities was abstracted from the contents of the 24 approved State Programs. Additional information concerning an activity may be obtained from the working contact of the Designated Agency for the State wherein the participating institution is located.

An over-all tabulation on page 18 is a comprehensive listing of approved STS activities by State Programs, under four major categories of technical services.

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It is hoped that this description of representative activities will promote discussion among the States concerning their respective approaches and common problems and thus stimulate new thoughts with respect to program content and format for technical services that will be offered subsequently.

Finally, this issue highlights the special merit programs funded by the Office of State Technical Services during Fiscal Year 1966. The Act provides for the support of these programs which are intended to stimulate technical services having broad national or regional significance and employing new methods or techniques generally not included in the State Programs. Information concerning these projects may be obtained by writing to the individual listed as project director.

INFORMATION DISSEMINATION SERVICES

Information System Program.—This program will develop a state retrieval system for material from information sources including Federal Government, State agencies, professional societies, colleges, universities, and others both in and out of the State. It is expected to be a regional program operated in cooperation with other Midwestern States.—University of Arkansas, Little Rock, Arkansas.

Public Library Scientific and Technical Information Network.—A regional system of reference centers envisioning the use of computers and reading machines for monitoring and disseminating current scientific and technical information will be planned. The system will be a part of an existing public library system which serves industry and commerce.—California State Library, Sacramento, California.

Information Services for Industries.—Information services will be organized for the following State industries: minerals, sand, gravel, clay, glass, tile, clay pipe, brick, porcelainware abrasives, and electronic-ceramics. The services will include information on recent technical advances and new methods of processing and control, and demonstrations on new production methods.—University of Florida, Gainesville, Florida.

Dissemination of Technical Information.—A center will be established to search out, list, contact, and determine the availability of technical information from the several major sources throughout the United States. This information will be disseminated to technically based firms whose records indicate related interests.—Iowa State University, Ames, Iowa.

Kansas Technical Services Centers and Field Offices.—These Centers will monitor incoming information, encourage improved communication between colleges, universities and industry, and maintain close liaison with the designated agency. The Center will also coordinate the work of its three field offices which will serve as regional technical service centers. Field offices will receive, analyze, and direct available and pertinent technical information to appropriate industries.—Kansas State University, Manhattan, Kansas; The University of Kansas, Lawrence, Kansas; Wichita State University, Wichita, Kansas.

Information Retrieval and Dissemination.—Each of the participating institutions will appoint a resident manager who will be responsible for establishing the mechanics of an information dissemination system in the area served by his institution under the State Technical Services Act of 1965. The participating institutions will select a State systems manager for technical services who will be responsible for supervising the development of a statewide information program and for coordinating the technical services programs of the participating institutions involved. The ten State-supported schools have formed the College and Universities Technical Services Council to function as an executive board. Finally, the resident managers will conduct field studies on the needs of business in their region.—All Michigan Participating Institutions.

Activity Management.—This information service will prepare and disseminate technical reports, abstracts, computer tapes, microfilms, and other reviews of scientific and engineering information.—University of Minnesota, Minneapolis, Minnesota.

Cooperation with the Clearinghouse for Federal Scientific and Technical Information.—The University of Missouri Extension Service field staff will contact local firms beyond the reach of the Department of Commerce field offices to make arrangements for the selective dissemination of the Fast Announcement Service and retrospective packaged reviews published by the Clearinghouse for Federal Scientific and Technical Information, and to acquaint industrial executives with the other services of the Clearinghouse.—University of Missouri, Columbia, Missouri.

Information Center.—This activity for companies in the Southern Tier area of New York, will include the development and operation of a technical information center which will publish digests of significant technical developments.—Cornell University, Ithaca, New York.

Bibliography and Abstract Service.—Library resources, including foreign language publication for the graphic arts and garment industries, will be developed for the New York City area and Westchester, Rockland and Orange Counties. In addition, a format for a monthly bibliography and abstract service will be prepared.—New York University, New York, New York.

Information Center.—An information center will be established for newspaper, commercial printing, and related firms to disseminate new technology of interest to the newspaper and printing industries. The sources of information will include the Rochester Institute of Technology as well as other research laboratories.—Rochester Institute of Technology, Rochester, New York.

Computer-Based Data Bank of Updated Information.—A computer-based data bank of updated technological information for firms in the Buffalo area will be established. The existing computer center at the University will be used to make maximum use of existing Federal, State and local repositories of technical information.—State University of New York, Buffalo, New York.

Library Information Service.—Mechanisms to handle information requests will be developed for companies in Nassau and Suffolk Counties and operated by a technical library staff familiar with the needs of local industry.—State University of New York, Stony Brook, New York.

Technical Information Dissemination Service.—The service for companies in Central New York will supply selected scientific and engineering information based on individual interest profiles. Inventories of technical information resources will also be compiled.—Syracuse University, Syracuse, New York.

Technical Information Center.—Scientific and technical knowledge will be made available to the industrial community by acquiring information resources and by seminars on the services of the Technical Information Center.—North Carolina State University, Raleigh, North Carolina.

Problem Identification.—A staff member at Southeastern State College will serve as liaison between the State Technical Services staff, and the National Aeronautics and Space Administration sponsored Technology Utilization Center. He will also develop specific program for answering needs of local businessmen by using information available at the Technology Utilization Center—Southeastern State College, Durant, Oklahoma.

Penntap (Pennsylvania Technical Assistance Program) Information Center.—An experimental information center will be established with activities including definition of needs and problems of industry; gathering, organizing and analyzing technical information; and serving as a mechanism for the transfer and dissemination of this knowledge.—Franklin Institute, Philadelphia, Pennsylvania.

Reorganizing Technical Information Files.—Existing files on aerospace technology at the University of Pittsburgh will be reorganized and made available to the State institutions qualified to participate in PENNTAP (Pennsylvania Technical Assistance Program). This effort represents one phase of an overall statewide technical information switching program. —University of Pittsburgh, Pittsburgh, Pennsylvania.

Industrial Research Advisory Program.—The Tennessee Industrial Research Advisory Program (TIRAS) will be expanded to include an information dissemination service.—The University of Tennessee, Nashville, Tennessee.

Information Retrieval.—This information Service for businesses in the Dallas area will provide "demand searches" of the Southern Methodist University's document collection. The activity will also provide a "current awareness" service for the solution of specific problems by supplying users with a bibliography of relevant reports on a bi-weekly basis.—Southern Methodist University, Dallas, Texas.

Document Distribution.—This information service will provide business and industry in the Dallas area with access to technical reports resulting from government sponsored research and development programs.—Southern Methodist University, Dallas, Texas.

Information Retrieval and Dissemination Center.—This information center will acquire, review, evaluate, prepare, and disseminate engineering and technical information to individual industrial organizations.—University of Utah, Salt Lake City, Utah.

Technical Information Service.—Existing library technical literature holdings in the Spokane metropolitan area will be expanded to include information from abstracting and indexing services, and government documents. These resources will then be made available to area industry.—Gonzaga University, Spokane, Washington.

Information Retrieval, Processing and Analysis.—This information service will collect, identify, analyze, and disseminate new technological information from a wide range of sources. The resources of the Unversity of Wisconsin library, other special libraries in the State and federal agencies will be utilized. Contact with industrial firms and a survey of their needs will also be initiated.—University of Wisconsin, Madison, Wisconsin.

University-Industry Research Information Services.—An office at the University of Wisconsin at Madison will be established to answer requests for technical information from industry and from "switching points" at Milwaukee and Wausau. It will also function as a switching center to other university, federal, state and private sources of expertise.—University of Wisconsin, Madison, Wisconsin.

REFERRAL SERVICES

Referral Service.—Directories of organizations and individuals offering professional and technical services will be compiled for use by industry and businesses in Arkansas. Initial fields to be covered will include accounting and auditing, engineering, finance, government services, management services, market research, and product research and development.—University of Arkansas, Little Rock, Arkansas.

Technical Manpower Register.—Modern data handling methods will be used to locate specialists in various fields, in response to expressed needs of various industries. These specialists may be required as private consultants in such group activities as special conferences or institutes.—University of Florida, Gainesville, Florida.

Register of Scientific Engineering and Management Manpower.—The information files of the Georgia Technical Services Program will be extended to include a current register of scientific and engineering personnel.—Georgia Institute of Technology, Atlanta, Georgia.

Directories of Specialized Personnel, Facilities and Services.—Rosters of consulting engineers, management consultants, university specialists and specialized facilities and servces will be developed and prepared for use by business and industrial organizations.—Research Foundation of Kansas, Topeka, Kansas.

Directory of Professional Services.—A comprehensive publication will list professional and business services to provide a rapid and orderly method of identifying and locating sources of technical and management expertise dealing with the problems and needs of industrial firms.—University of Missouri, Columbia, Missouri.

Inventory of Faculty Expertise.—An inventory will be prepared of the specific areas of competence and interests of the University of Missouri faculty. Classified listings will be prepared for ready access and use in matching the problems and needs of industrial firms with available sources of expertise.—University of Missouri, Columbia, Missouri.

Industrial Referral Service.—This activity will consist of direct assistance to industrial firms in obtaining published information or locating sources relating to propretary interests. Services to be rendered many include identification and definition of problems; suggestions of alternative procedures for solving these problems, the location of sources of published and unpublished literature, and, referral to sources of professional expertise.—University of Missouri, Columbia, Missouri.

Food Processing Technology Referral Service.—A list of available laboratories, consultants, products, and machinery will be compiled and made available to food industries.—Cornell University, Ithaca, New York.

Referral Service.—This reference service for business concerns in the Southern Tier area of New York will supply on demand, sources of technical information, references to literature, and lists of consultants.—Cornell University, Ithaca, New York.

Referral Service.—A list of technical and business consultants, for the graphic arts and garment industries, will be compiled covering New York City and Westchester, Rockland, and Orange Counties.—New York University, New York, New York.

Geologic Referral Service.—A geologic reference and referral file will be compiled for publication and distribution to industries in this field. Follow-up and evaluation procedure will also be initiated on referrals.—Rochester Institute of Technology, Rochester, New York.

Referral Service.—This activity for the ceramic industry involves the formation of an advisory panel which will refer technical inquiries to relevant individuals or organizations.—State University of New York, Alfred, New York.

Referral Service.—A referral service will be operated for small business in the Buffalo area to provide a link with competent professional and technical services.—State University of New York, Buffalo, New York.

Referral Service.—This activity for the wood industry will represent expansion of an existing referral service. Firms in the wood and forest products industries will be referred to sources of technical expertise.—Syracuse University, Syracuse, New York.

Nuclear Science and Technology Referral Service.—A referral service will be organized to refer industrial users of nuclear technology to sources of information or expertise. This service will utilize the information retireval service of the computer center to be established at the State University of New York at Buffalo. In addition, sources of qualified consultants will be provided.—Western New York Nuclear Research Center, Inc., Buffalo, New York.

Industrial Service and Research.—An Industrial service and research institute for small businesses will be set up. One function will be the referring of small businessmen to agencies or organizations offering technical help. A second will be to assist entrepreneurs in the marketing of their products.—Oklahoma State University, Stillwater, Oklahoma.

Directory of Technicians.—This directory will permit quick identification of experts. It will be organized by specific fields of interest, giving names, titles, and telephone numbers of individuals in universities, private consulting firms, and government agencies.—Puerto Rico Economic Development Administration, San Juan, Puerto Rico.

Industrial Research Advisory Program.—The Tennessee Industrial Research Advisory Program (TIRAS) will be expanded to include a referral service offering information on sources of expertise in the State.—University of Tennessee, Nashville, Tennessee.

Referral Service.—The referral service for companies in the Dallas area will function as a switching mechanism by referring inquiries to appropriate centers or services. In addition, the referral service will provide source guidance so that appropriate manufacturers of a given product needed by the user can be located when needed.—Southern Methodist University, Dallas, Texas.

Directory of Industry Services.—A directory of engineering, scientific, and management services will be prepared listing private and public agencies which are qualified to render services to industrial firms.—University of Utah, Salt Lake City, Utah.

FIELD SERVICES AND INDUSTRIAL LIAISON

Field Services.—Field services will be used to assist firms in identifying and solving problems. Field service agents will be individuals familiar wth sources of scentific and technological information.—University of Arkansas, Little Rock, Arkansas.

Field Implementation of Disseminated Information.—This field study will counsel and assist individuals and firms in locating technical information.—Iowa State University, Ames, Iowa.

Wood Industry Field Service.—This activity will provide the woodusing industry with the results of research conducted by various agencies, and familiarize them with publications pertaining to various operations, such as procurement, sawing, drying and gluing.—Louisiana Polytechnic Institute, Ruston, Louisiana.

Field Service Program.—Field agents will visit Nassau and Suffolk Counties to discuss industrywide problems, and to assist in determining solutions to specific problems. The needs of industry in the area will also be ascertained in this phase of the program.—State University of New York, Stony Brook, New York.

Information Assistance for Industrial Development.—Area industrial development associations will be assisted through field service contacts and meetings aimed at disseminating technical information for the improvement of industry operations.—North Carolina State University, Raleigh, North Carolina.

Regional Industrial Services.—A field service activity will be established to assist local businesses and industries in identifying and solving specific technological problems. Visits will be made on a request or referral basis.—North Dakota University, Fargo, North Dakota.

Technical Services Field Staff.—Two full-time staff members will maintain regular contact with businesses. They will identify problems and refer businessmen to facilities of participating institutions or other agencies and organizations capable of providing problem solving aids.—Oklahoma State University, Stillwater, Oklahoma.

Local Technical Advisors Program.—This program will give technical advice through plant visits to local factories. The aim of the technical advice is to reduce costs in manufacturing firms; to improve their technical and managerial organization; and to bring to their attention new materials, manufacturing techniques, processes, machinery, and systems. The service is for small business and manufacturing companies.—Puerto Rico Economic Development Administration, San Juan, Puerto Rico.

Industrial Research Advisory Program.—The Tennessee Industrial Research Program (TIRAS) will be expanded to include a program of field visits to industry.—University of Tennessee, Nashville, Tennessee.

Field Service.—This project will provide field service to assist firms in the Dallas area in implementing new technology in their activities.—Southern Methodist University, Dallas, Texas.

Scientic and Technical Information.—The field service staff will introduce management in the primary metals and electronic components and accessories industries to available scientific and technical information resources related to their fields.—Texas A&M University, College Station, Texas.

Technical Service Field Work.—This activity will: (1) acquaint business management with State Technical Services Act and the Utah Industrial Services Agency; (2) identify specific technical problem areas and initiate technical assistance programs; and (3) develop input data for a master file of Utah industrial firms.—University of Utah, Salt Lake City, Utah.

Technical Information Field Offices.—Field offices will be established in the Wausau and Milwaukee areas to: (1) maintain basic reference materials, (2) provide referral records for sources of expertise, (3) assist in the interpretation and application of technical information at the point of use, (4) provide diagnostic aid to defining problems and needs of businessmen, (5) assess local needs for educational activities such as conferences, classes and workshops, and (6) refer industry to sources of expertise, federal, state and private.—University of Wisconsin, Wausau and Milwaukee, Wisconsin.

DIRECTED NEWS OF STS ACTIVITIES IN STATES

State Technical Services Program Announcement Activity.—This program will inform the business community of the Florida Technical Services Program. Specific activities will include provision of engineering and other technical speakers for civic, business, and technical groups; release of fact sheets assembled from the programs of the participating institutions will be distributed.—University of Florida, Gainesville, Florida.

Information on State Technical Service Programs.—A monthly publication for the participating institutions in Iowa will be prepared and distributed. This publication will be a vehicle for public information about meetings and other programs for Iowa business and industry under the State Technical Services Act of 1965.—Iowa State University, Ames, Iowa.

Public Information and Education.—In order to familiarize industry with the Kansas Technical Services Program, a brochure will be prepared and distributed, and several conferences will be held for professional, technical and industrial groups. Research Foundation of Kansas, Topeka, Kansas.

Publication of Pamphlet.—A pamphlet will be prepared describing the purposes of the State Technical Services Act and the program and services of the University of Missouri for implementing the Act.—University of Missouri, Columbia, Missouri.

Information Service.—This activity for the food industry will involve the publication of a periodic newsletter or bulletin containing food processing information derived from Cornell's library facilities. Special communications will occasionally be sent to specific segments of this industry.—Cornell University, Ithaca, New York.

Bibliography and Abstract Service.—Library resources, including foreign language publications, for the graphic arts and garment industries, will be developed for the New York City area and the Westchester, Rockland and Orange Counties. In addition, a format for a monthly bibliography and abstract service will be prepared.—New York University, New York, New York.

Technical Library Services.—This three-part program will extend services of the Rensselaer library to industry in the Capital District of New York. First, a monthly information newsletter containing current information on innovations, new processes, etc., will be prepared and distributed. Second, subject bibliographies or title listings will be developed based on searches in the RPI collection. Third, the library holdings will be augmented and made available to area industry based on indicated local needs and interests.—Rensselaer Polytechnic Institute, Troy, New York.

Graphic Arts Progress Information Services.—The existing bulletin, Graphic Arts Progress, will be expanded to include a greater scope and content and provide a wider distribution.—Rochester Institute of Technology, Rochester, New York.

Management Information.—Bulletins and a monthly newsletter will be prepared and released to satisfy the needs of local management regarding industrial and technical information.—Puerto Rico Economic Development Administration, San Juan, Puerto Rico.

Promotional Brochure.—This brochure describes the type of field services which will be offered under the Puerto Rico Five Year Plan. The brochure will be widely distributed to industry and commerce.—Puerto Rico Economic Development Administration, San Juan, Puerto Rico.

Technical Service.—Current industrial engineering techniques, and new information will be surveyed and made available to the technical and management personnel of textile plants. Technical brochures and booklets will be prepared and disseminated to assist in operation and management.—The University of Tennessee, Knoxville, Tennessee.

Technical Information Service Brochure.—A technical services general information brochure be published describing the objectives, services, and organization of the Utah Industrial Services Agency. This multiple-use document will be disseminated through mailings, public meetings, and personal visits.—University of Utah, Salt Lake City, Utah.

Technical Information Newsletter.—Five newsletters will be issued to inform the business community of technical services developments and to serve as a means for continuing contact.—University of Utah, Salt Lake City, Utah.

Public Information.—The activities of the Utah Industrial Services Agency will be publicized through discussion meetings, speaking engagements, news releases, direct mail, or personal visits.—University of Utah, Salt Lake City, Utah.

Newsletter and Directory.—A newsletter will be distributed by the administrative staff of the State Technical Services Program. It will provide information to the state's industry and individuals interested in the Wisconsin program.—University of Wisconsin, Madison, Wisconsin.

COURSES IN INFORMATION DISSEMINATION

Information Services for the Chemical Industry.—A curriculum will be developed for the preparation of a course on technical information services available to industrial chemical firms. Possible publication of course materials is foreseen.—University of California at Los Angeles, Los Angeles, California.

Obstacles to the Transfer of Technology.—A one-day conference will be held at which papers will be presented on innovation and transfer of technology. A panel discussion will follow and the proceedings will be drawn from the following aspects of technology transfer: communications barriers to transfer, proprietary rights barriers, financial and entrepreneurial barriers, analytical barriers, and institutional barriers.—University of California at Los Angeles, Los Angeles, California.

Federal Technical Information Services.—A curriculum will be developed and preparations wil be made for a course directed toward giving the business community a wider knowledge of the technical information services provided by the Federal Government. Possible publication of course materials is foreseen.—University of California at Los Angeles, Los Angeles, California.

Operations and Services of Technical Information Centers.—A course designed to acquaint potential information center staff members with the uses and opera-

tions of technical information centers will be perpared. Possible publication of course materials is foreseen.—University of California at Los Angeles, Los Angeles, California.

Management, Technical and Scientific Information.—Conference training will be provided for the management of small business establishments in the interpretation and application of scientific and technical information in company operations.—University of Georgia, Athens, Georgia.

Innovation and Technology Transfer Techniques.—Using a hypothetical model of a large corporation, this program for management will cover the effective use of science and technology and available information resources. In addition alternative models for using such resources wil be examined.—Wayne State University, Detroit, Michigan.

Innovation and Technology Transfer Techniques.—A program for the small company will deal directly with the identification and use of information sources available to small business.—Wayne State University, Detroit, Michigan.

Technical Services Program.—The activties of the Minnesota Technical Services Program will be explained to individuals and organizations in the State who might derive benefits from these services. Presentations at Minneapolis-St. Paul, Duluth, Moorhead, Mankato and Rochester will explain the methods and procedures that will be used to achieve technology transfer. Emphasis will be on how the programs can be of value to Minnesota businesses.—State of Mnnesota Department of Business Development, St. Paul, Minnesota.

Source of Information.—A one-day conference will feature, for business and industry research personnel, the availability of various sources of information and materials in scientific and technical fields. Statistical information, patent information, R&D reports, specifications, and government documents in general will be discussed.—St. Louis University, St. Louis, Missouri.

Technical Innovation.—A two-day conference will be offered to focus public attention on roles of Federal and State governments in providing technical services to industrial and commercial firms.—University of Missouri, Columbia, Missouri.

Technology Transfer in Civilian Business and Industry.—This conference will encourage industry in the Rochester area to identify possible applications of technology by pointing out factors and problems affecting technology transfer.—University of Rochester, Rochester, New York.

Techniques of Operating a Technical Information Center.—As part of the overall information switching program, a one-day travelling seminar will be conducted at participating institutions in the State to provide instruction in the use and maintenance of information files, and in techniques developed by the Knowledge Availability Systems Center.—University of Pittsburgh, Pittsburgh, Pennsylvania.

Technical Information Resources.—This workshop will acquaint the small businessman in the Dallas area with the vast amount of technical information available from government-sponsored research programs, and the services available at the Science Information Center.—Southern Methodist University, Dallas, Texas.

Effective Information Dissemination.—The purpose of this activity is to acquaint smaller petroleum companies with information pertaining to prospecting, drilling, producing, transporting, refining, and marketing of petroleum and its products; and to ascertain the most effective method for the dissemination and utilization of this information. This objective will be accomplished through the means of interviews conducted by the field service staff.—Texas A. & M. University, College Station, Texas.

Information Technology and Services.—Course materials will be developed for a summer institute to acquaint the technical libraries with the theory and techniques of information storage and retrieval.—Texas A. & M. University, College Station, Texas.

USE OF EDUCATIONAL T.V.

Educational Materials for the Ceramic Industry.—A series of films or television tapes on various fields of interest to the ceramic industry will be prepared and subsequently made available to the industry. Members of the faculty of the College of Ceramics will also visit designated areas for discussions on the subject matter of the film.—State University, of New York, College of Ceramics, Alfred University, Alfred, New York.

Use of Educational Television.—A study and evaluation of current educational television methods will be directed towards improving the use of the State's educational television facilities. The project will include cataloguing available video tapes on scientific and technical subjects, summarizing the existing and planned uses of education television throughout the nation, and evaluating the effectiveness of existing programs.—North Carolina State University, Raleigh, North Carolina.

Management Information Systems.—A two-hour television program combined with discussion groups in four areas of the State is intended to acquaint business managers in medium and small sized industries with guidelines for establishing information systems in their respective firms. The program will be presented on educational television stations in Tulsa and Oklahoma City.—Oklahoma State University, Stillwater, Oklahoma.

Management Information Systems Seminars.—Three seminars consisting of six weekly two-hour sessions will be held in a number of Oklahoma communities. They are intended as a follow-up to the television session and will give more detailed study to the application of information systems to small businesses.—Oklahoma State University, Stillwater, Oklahoma.

Televising Conferences.—A maximum of three hours of selected conferences and seminars held at The Pennsylvania State University will be video taped, and subsequently transferred onto film. The final product will consist of individually-filmed programs available for use by technical groups.—The Pennsylvania State University, University Park, Pennsylvania.

COURSES IN USE OF COMPUTERS IN BUSINESS

Electronic Computers in Business.—A one-day conference will feature topics such as Electronic Data Processing (EDP), integrated systems technology, the processing cycle, computer units, programming, the feasibility study, payout applications, long range contributions of EDP, and personnel aspects of conversion to EDP.—University of Arkansas, Little Rock, Arkansas.

Application of Computer Simulation to Problems of Physical Distribution Models.—A program of study on the use of TRANSIM in the solution of physical distribution problems will be offered to managers of transportation and distribution organizations. TRANSIM is a method of simulating transportation and/or distribution problems on a computer.—University of California at Los Angeles, Los Angeles, California.

Computer Sciences for Small Business.—The rational methodical and effective application of computers in small businesses will be developed at a one-day seminar.—Brevard Engineering College, Melbourne, Florida.

Management Science.—Seminars will be conducted on the application of inventory management, computer simulation, and linear programming to management decision-making.—University of Georgia, Athens, Georgia.

Computers, Computations, and Computational Mathematics.—A course for research scientists and engineers will be offered on the organization of modern computer systems, including the structure of current and future programming systems. The meaning and results of an algorithmic procedure, as well as the basic underlying mathematics of numerical algorithms, will be discussed.—University of Illinois, Urbana, Illinois.

Industrial Applications of the Computer.—A seminar on computer applications to the manufacturing and packing industries will be held for middle and upper management personnel.—Clark College, Dubuque, Iowa.

Digital Computers in Industry.—This course will provide industrial management and engineering personnel with an understanding of computer technology and will include the language limtations and data requirements. The computer's role in management will be especially stressed.—Iowa State University, Ames, Iowa.

Electronics and Manpower in Banking.—This seminar will be designed to explain to banking management the benefits obtained through the use of computers and electronic equipment in the banking profession.—Morningside College, Sioux City, Iowa.

Computer Technology for Business Usage.—A workshop for the industrial community of Northern Louisiana will acquaint management with the values of analog and digital computers and with the impact of computers on industry. An opportunity to practice computer techniques will be provided to participants.—Louisiana Polytechnic Institute, Ruston, Louisiana.

Data Processing for Small Business.—A one-day conference will be directed at motivating management of small and medium-sized companies to examine the potentials of electronic data processing. The conference will be followed by a series of closed circuit television presentations, training films, and taped portions of the conference. It is estimated that approximately twenty half-hour programs will be developed.—Northern Michigan University, Marquette, Michigan.

Computer Technology.—The topics in this one-day conference of interest to small and medium-sized businesses will include potential profitability of computers, evaluation of the benefits of Electronic Data Processing (EDP), acquisition of an EDP capacity, computer operation and organization, communication with a computer and computer time-sharing operations.—University of Michigan, Ann Arbor, Michigan.

Computer Graphics and Time Shared Computers.—This two-day workshop will be a follow-up program of the preceding computer technology conference. Its contents will be determined largely by the specific interests and qualifications of the conference attendees.—University of Michigan, Ann Arbor, Michigan.

Information Systems and Computers.—An eighty-hour course will be devoted to managerial considerations in systems design, the role of operations research and econometrics within an information system, and recent developments in computer hardware.—University of Minnesota, Minneapolis, Minnesota.

Use, Value, and Dangers of Computers in Small Business.—This short course will cover the applications and values of the computer for sales analysis, accounting, production, inventory, and payroll. Discussions will evaluate the strengths, weaknesses, and dangers of computer systems. No previous knowledge of automated data systems will be necessary.—Washington University, St. Louis, Missouri.

Remote Terminal Computer Systems.—This institute for engineers and applied scientists will be concerned with the acquisition, financing, operation, programming, and other aspects of remote-terminals coupled to large computer systems.—Washington University, St. Louis, Missouri.

Introduction to Digital Computing.—Businesses in the Southern Tier area of New York will be offered a short course on digital computing that will cover basic instruction in programming techniques; and include a discussion of current and potentially available computer equipment and computer applications. A summary of the capabilities and economics of digital computers in support of research, engineering and industrial administration will also be presented.—Cornell University, Ithaca, New York.

Business and Industrial Computer Use.—A conference for small business management will survey existing computer programs to demonstrate the feasibility of using computers by firms presently unable to afford the ownership of computer equipment.—Tennessee Technological University, Cookeville, Tennessee.

Computers and Industry.—The content of this three-day course will include computer technology and its limitations.—College of the Virgin Islands, St. Thomas, Virgin Islands.

Applications of Data Processing.—A ten-week institute for small businessmen in the Spokane area will be conducted to provide training and skill in management decision-making. A computer simulation game will be run, along with workshops on the following subjects: (1) functions of management and business leadership, (2) electronic data processing as it affects modern business operations, (3) scientific decision-making techniques, (4) cash flow analysis and use of funds statements, (5) sources of capital, (6) financial planning and control for small business, (7) problems in buying, (8) inventory modeling, and (9) forecasting and planning for profits.—Eastern Washington State College, Cheney, Washington.

COURSES IN SPECIALIZED TECHNOLOGY

Wood Technology

Recent Scientific and Technological Developments in Wood Utilization.—This two-day workshop which will cover recent scientific breakthroughs in wood and fiber utilization is designed for management and technical personnel of the Northern California lumber and wood products industries.—Humboldt State College, Arcata, California.

Wood-finishing.—New developments in wood finishing for management and factory workers of wood-using industries will be presented in a short course. Subject matter will include wood anatomy, properties of wood, wood finishes, finishing systems, finishing techniques, and quality control. This course will be offered in two areas of the State.—University of Illinois, Urbana, Illinois.

Kiln-Drying.—The process of seasoning green or air-dried lumber for conversion to more usable products will be covered in a short course for wood-using industry management and primary supervisory personnel. The subject matter will include wood-liquid relations, air seasoning vs. kiln-drying, thermodynamics of kiln-drying, preparing kiln schedules, and quality control of the seasoning process. This course will be offered in two areas of the State.—University of Illinois, Urbana, Illinois, and Southern Illinois University, Carbondale, Illinois.

Wood Drying.—A short course will furnish information on drying of products that can be applied to various phases of the wood-using industry. Methods of moisture removal, moisture determination, types of kilns, and stacking methods will be discussed. The course will involve the use of the school's dry kiln.—Louisiana Polytechnic Institute, Ruston, Louisiana.

Hardwood Log and Lumber Grading.—A course for the woodworking industry will review basic hardwood lumber and log grading and their correlation. The objective of this activity is to enable industry personnel to accurately determine the grade and value of hardwood timber stands.—Louisiana Polytechnic Institute, Ruston, Louisiana.

Wood Products Marketing.—An introductory conference on the function and role of the University of Montana as a continuing source of technical information in wood technology. New marketing techniques and their application to forest products will also be presented.—Montana University, Missoula, Montana.

Forest Products.—Two seminars will be directed toward channeling new research to the needs of small wood processing industries. They will (1) emphasize the application of new scientific principles to the development of wood processing technology, and (2) highlight the use of management tools such as statistical quality control, operations research, and systems analysis in the solution of small-firm problems.—University of Washington, Seattle, Washington.

Regional State Technical Services Conferences.—These conferences, for management personnel of medium sized companies, will be held in five different regions throughout the state to highlight new development in technology. The programs will feature (1) machining of metals, (2) wood processing, (3) electrical insulation, (4) preservation of foods, (5) non-destructive testing, (6) fluid power, (7) value assurance and computer technology, applications to industrial problems, and (8) powder metallurgy. Topics will be related to industries located within each region.—University of Wisconsin, Madison, Wisconsin.

Metal Working

Introduction of Numerical Control Technology.—A series of four one-day seminars for the metal working industry, especially small tool and die shops, will be offered during the year on the general subject of numerical control. Specific items will include the introduction to symbolic control, manual programming of numerical control machine tools, computer-aided programming and cutting of a typical part, plant preparations required to incorporate numerical control techniques, and management in numercial control.—Illinois Institute of Technology Research Institute, Chicago, Illinois.

Automatically Programmed Tools-Part Programming-Basic Course.—This course for metal working industries will highlight fundamental concepts and techniques of Automatically Programmed Tools (APT) Part Programming. The subject matter will include APT languages, techniques of Part Programming, concepts of tools and workpiece geometry, a point-to-point program, and a two-dimensional program.—Illinois Institute of Technology Research Institute, Chicago, Illinois.

Automatically Programmed Tools-Part Programming-Advanced Course.—This activity for metal working industries will consist of an advanced course in APT Part Programming for which the APT Part Programming Basic Course is a prerequisite. The subject matter will include repetitive programming, geometry manipulation by matrices, special surfaces, and multi-axis programming.—Illinois Institute of Technology Research Institute, Chicago, Illinois.

Advanced Applied Automatically Programmed Tools.—Several workshops (of four to six people each) will be organized for metal working industries in solving practical Automatically Programmed Tools (APT) problems. Prerequisites for participation are the APT Part Programming Basic Course and the Advanced Course.—Illinois Institute of Technology Research Institute, Chicago, Illinois.

Basics of Numerical Control.—Basic information on numerical control for metal working industries will be presented at a seminar. The subject matter in relation to numerical control will include the history and advantages of numerical control, management implications, use in product design, positioning controls,

point-to-point work, contouring, manual programming, servomechanisms, and inspection and testing.—Illinois Institute of Technology Research Institute, Chicago, Illinois.

Metal Casting.—This seminar for foundry supervisors will be designed to present the latest technological developments in metal casting.—State University of Iowa, Iowa City, Iowa.

Three-Dimensional Contouring.—Recent research findings in the area of three-dimensional contour machining in the machine tool industry, and the effect of these findings as applied to production problems, will be highlighted in a two-day workshop for participants from Western Michigan industry.—Ferris State College, Big Rapids, Michigan.

Metallurgy of New Materials and Tooling.—A two-day seminar will be presented to participants from the machine tool industry of Western Michigan. Pertinent research findings regarding the development of new metals and related tooling techniques will be discussed. The material prepared for the seminar will be assembled into a compendium for further dissemination.—Ferris State College, Big Rapids, Michigan.

Modern Metal-Working Techniques.—This conference for engineers and managers will emphasize the uses of new machining, forming and joining methods.—University of Missouri, Kansas City, Missouri.

Theory and Practice of Numerical Control.—Representatives of manufacturing facilities will be trained in numerical control as applied to metal working processes. The capabilities, advantages, and limitations of numerical control will be covered.—University of Chattanooga, Chattanooga, Tennessee.

Mineral Industries

Applications of X-ray Methods to the Mineral Industries.—A one-day conference for mining and mineral processing personnel will cover the theory of X-ray diffraction and fluorescence; and the application of X-ray technology to elemental analysis as a tool for automatic control and mineral exploration. Other technical uses of X-rays by the mineral industry will also be covered.—Michigan Technological University, Houghton, Michigan.

Rock Mechanics.—A conference for mining engineers and supervisors will cover rock mechanics in mining and construction.—University of Missouri, Columbia, Missouri.

Availability and Utilization of Mineral Resources.—Two or more short courses for disseminating current research information on the development of new uses of mineral resources will be offered to producers and users of mineral products.—North Carolina State University, Raleigh, North Carolina.

Electronics

Technical Services For Aerospace, Electronic, and Other Science-Oriented Firms.—A conference will be held covering vacuum and electronics development, and advances in instrumentation and basic research. Regional field trips will be made to determine the subjects of the most immediate interest to the largest number of Florida industries.—Florida State University, Tallahassee, Florida.

Technology Training.—A series of conferences will be offered on computer technology, chemical instrumentation, and electronics for scientists, engineers and businessmen.—West Georgia College, Carrollton, Georgia.

Electronics Research.—This review of the results of recent research in electronics for research management will cover the areas of antenna theory, aeronomy, circuit theory, computer systems design, digital and analog computer circuitry, low temperature physics and superconductivity, microwaves, plasma electronics, and solid state electronics.—University of Illinois, Urbana, Illinois.

Use of Transistors and Other Solid State Devices for Industrial Application.—Twelve weekly, three-hour seminars will be offered to electrical engineers. Basic circuit and transistor theory will be discussed.—Louisiana Polytechnic Institute, Ruston, Louisiana.

Power Semi-Conductors.—A symposium for electrical engineers will present new developments in the use of power semi-conductors for industrial applications, including electrical controls.—University of Missouri, Columbia, Missouri.

Solid State Electronics.—A short course on solid state electronics will be held for engineers and scientists in the communications and aerospace industries.—University of Missouri, Columbia, Missouri.

Construction Industry

Construction Industry Technical Services.—Manuals and teaching materials will be prepared for group instruction of industry management and supervisory

personnel in the heavy construction industry. The latest techniques and criteria for selecting heavy construction equipment by unit size, type, fleet size, hours worked, and working conditions will be presented.—University of Florida, Gainesville, Florida.

Home Building.—A short course for engineers, residential developers and contractors will be held at various locations on the subject of new materials and methods of construction.—University of Missouri, Columbia, Missouri.

Soils and Foundations.—A three-day conference for the construction industry will be devoted to explaining and demonstrating new information on soils and their bearing qualities, and new theories and practices of foundation construction.—Oklahoma State University, Stillwater, Oklahoma.

Mechanics of Heavy Equipment Operation.—This three-day workshop for industrial construction firms, will highlight the mechanics of heavy equipment operation.—College of the Virgin Islands, St. Croix, Virgin Islands.

Food Processing

Extension of Shelf-life of Foods.—This seminar for food processors, distributors and retailers will offer information related to nonmicrobial spoilage mechanisms and gas and vapor permeability factors in packaging materials.—Louisiana Polytechnic Institute, Ruston, Louisiana.

Plant Instrumentation and Control.—This thirteen-week course for engineers in the process industries (chemicals, plastics, fibers, petroleum, food drugs, etc.) will feature practical applications of existing control theory. An elementary background in process dynamics and control, and some practical experience will be required for participants.—Washington University, St. Louis, Missouri.

Development of Seminars.—A series of workshops and seminars for business organizations in Central New York will be developed. A suggested workshop is technical innovation and business planning. Suggested seminars are: new developments in food processing, biological contaminants, and waste pollution and control.—Syracuse University, Syracuse, New York.

New Processes and Applications of Radiation.—A program of two seminars and four demonstrations for food processing industries will provide information on the feasibility of radiation and other processes in the treatment of foods, tubers, and root stocks. One phase of the program will deal with the use of radiation for quarantine and control of diseases borne on root stocks and tubers.—University of Washington, Seattle, Washington.

Numerical Control

Numerical Control Technology.—Guidance will be offered to the metal working industries, through a field service program focusing on Automatically Programmed Tools Part Programming, numerical control processing problems, and applications of numerical control.—Illinois Institute of Technology Research Institute, Chicago, Illinois.

Casebook Reports and Newsletter on Numerical Control Technology.—Case histories of piece parts of interest to metal working industries will be gathered to illustrate the times required to program and machine the parts. Significant articles on numerical control and reports on significant new developments in the field will be disseminated.—Illinois Institute of Technology Research Institute, Chicago, Illinois.

Numerical Control.—Two two-day workshops for small and medium-sized businesses will cover topics such as the nature of numerical control, evaluation of its potential uses, differences between point-to-point and continuous path programming, procedures for acquiring numerical control capability and management modifications needed to exploit numerical control.—University of Michigan, Ann Arbor, Michigan.

Adaptive and Numerical Control.—A two and one-half day conference for individuals concerned with numerical control will feature computer-aided design and programming, adaptive control, machinability, single-point cutting tools, management practices, numerical control in the automotive industry, control system developments and machine tool developments.—University of Michigan, Ann Arbor, Michigan.

Operations Research

Operations Research.—A one-day seminar will be offered which is directed primarily at utilizing operations research techniques in establishing parameters for the solution of management and technical problems in the electronics and aerospace industries.—Brevard Engineering College, Melbourne, Florida.

Operations Research.—A series of eight-day symposia for management in large firms will be held at monthly intervals involving fields such as quantitative models, linear programming, transportation models, inventory models, production scheduling, Program Evaluation Review Technique (PERT) and Critical Path Method (CPM) techniques, organization theory, communications in the firm, dynamic programming, and sequential decision analysis.—University of Missouri, Columbia, Missouri.

Operations Research.—A three-day conference will be presented to disseminate basic knowledge of operations research techniques as applied to business and industry.—Oklahoma State University, Stillwater, Oklahoma.

Structural Mechanics

Report on Structural Mechanics Computer Programs.—Quarterly seminars for architects, engineering firms, and contractors will be held to give instruction in newly acquired computer programs. The last seminar will be a comprehensive review of the programs acquired during the year and the experience obtained. The results of this final seminar will be made available to the public.—Illinois Institute of Technology Research Institute, Chicago, Illinois.

Computer Programming for Structural Analysis.—A short course on computer programming for structural analysis will be offered to structural engineers.—University of Missouri, Kansas City, Missouri.

Engineering Education and Structural Engineering.—A two-day seminar for civil engineers will cover engineering education and structural engineering.—Montana State University, Bozeman, Montana.

Experimental Mechanics, and Shock and Vibrations in Engineering Materials.—This two-day seminar for civil engineers will cover engineering mechanics, and shock and vibrations in engineering materials.—Montana State University, Bozeman, Montana.

USE OF LIBRARIES IN STATE TECHNICAL SERVICES PROGRAMS

Public Library Scientific and Technical Information Network.—A regional system of reference centers envisioning the use of computers and reading machines for monitoring and disseminating current scientific and technical information will be planned. The system will be a part of an existing public library system which serves industry and commerce.—California State Library, Sacramento, California.

Mechanized Center for Information Services.—Plans and specifications will be developed for a program related to the mechanizing of proposed public library reference centers. This effort will be directed at increasing the operational efficiency of the centers, information-gathering and dispensing procedures by utilizing data in the form of magnetic tapes and micro-images.—UCLA, Los Angeles, California.

Structural Mechanics Computer Library Program.—A literature search will be made and an annotated bibliography of available computer programs in the field of structural mechanics is to be compiled for use by architects, engineering firms, and contractors. A selection of the programs listed will be made operational and, where necessary, problems will be solved to obtain experience with specific programs in order to better judge their usefulness.—Illinois Institute of Technology Research Institute, Chicago, Illinois.

Information Service.—This activity for the food industry will involve the publication of a periodic newsletter or bulletin containing food processing information derived from Cornell's library facilities. Special communications will occasionally be sent to specific segments of this industry.—Cornell University, Ithaca, New York.

Bibliography and Abstract Service.—Library resources, including foreign language publications, for the graphic arts and garment industries, will be developed for the New York City area and the Westchester, Rockland and Orange Counties. In addition, a format for a monthly bibliography and abstract service will be prepared.—New York University, New York City, New York.

Technical Library Services.—This three-part program will consist of the services of the Rensselaer library to industry in the Capital District of New York. First, a monthly information newsletter containing current information on innovations, new processes, etc., will be prepared and distributed. Second, subject bibliographies or title listings will be developed based on searches in the RPI

collection. Third, the library holdings will be augmented and made available to area industry based on indicated local needs and interests.—Rensselaer Polytechnic Institute, Troy, New York.

Library Information Service.—Mechanisms to handle information requests will be developed for companies in Nassau and Suffolk Counties and operated by a technical library staff familiar with the needs of local industry.—State University of New York at Stony Brook, Stony Brook, New York.

Procedures and Mechanisms for Technical Services.—Consultations will be held with Nassau and Suffolk County government and industrial leaders on ascertaining needs for area planning. Mechanisms and procedures will be developed for this activity through the use of library and other reference services.—State University of New York at Stony Brook, Stony Brook, New York.

Reference Service.—A technical inquiry service for industries in Central New York will be established. Materials in this collection will be kept current by a trained reference librarian. Sources will include New York State and United States Departments of Commerce pubications, industrial directories, various economic and regional development organizations, area surveys, and files of other State Technical Centers.—Syracuse University, Syracuse, New York.

Technical Service Library.—Technical data pertinent to the growth of small business firms and shop facilities will be accumulated and organized at the University of Oklahoma for use by local business and industry.—University of Oklahoma, Norman, Oklahoma.

Library Information Center.—This center will be a pilot system utilizing the Pennsylvania State University Libraries as part of a statewide system. A technical librarian will handle the establishment and organization of the program, including visits to business firms as part of the activity.—The Pennsylvania State University, University Park, Pennsylvania.

Reorganizing Technical Information Files.—Existing files on aerospace technology at the University of Pittsburgh will be reorganized and made available to the State institutions qualified to participate in PENNTAP (Pennsylvania Technical Assistance Program). In the first year the subject materials will be emphasized. This effort represents one phase of an overall statewide technical information switching program.—University of Pittsburgh, Pittsburgh, Pennsylvania.

Information Retrieval.—This information Service for businesses in the Dallas area will provide "demand searches" of the Southern Methodist University's document collection. The activity will also provide a "current awareness" service for the solution of specific problems by supplying users with a bibliography of relevant reports on a bi-weekly basis.—Southern Methodist University, Dallas, Texas.

Computer Applications in Information Handling.—This short course will aid industrial and academic librarians in taking advantage of the increasing number of computer tapes being prepared by Federally sponsored information centers.—Southern Methodist University, Dallas, Texas.

Science Information Center.—Library Services will be extended to local industry and small businesses in the Dallas area by offering a borrower's card which will entitle the holder to check out for three-week loan periods any book in the circulating collection of the Science Information Center.—Southern Methodist University, Dallas, Texas.

Technical Information Service.—Existing library technical literature holdings in the Spokane metropolitan area will be expanded to include information from abstracting and indexing services, and government documents. These resources will then be made available to area industry.—Gonzaga University, Spokane, Washington.

Chemical Information Service.—The holdings of the Pacific Lutheran Library will be made available to chemists in the Tacoma area. Lists of the University's chemical journal collection will be provided.—Pacific Lutheran University, Tacoma, Washington.

Information Retrieval, Processing and Analysis.—This information service will collect, identify, analyze, and disseminate new technological information from a wide range of sources. The resources of the University of Wisconsin library, other special libraries in the state and federal agencies will be utilized. Contact with industrial firms and a survey of their needs will also be initiated.—University of Wisconsin, Madison, Wisconsin.

SPECIAL MERIT PROGRAMS

Two Summer Institutes in Mass Spectroscopy and Advanced N.M.R.—This program for industrial chemists will present an advanced course in the interpretation and analysis of data derived from mass spectroscopy and nuclear magnetic resonance (N.M.R.). There will be twenty formal lectures scheduled during the week; afternoons will be reserved for actual experience in using spectrometers, computers, and interpreting spectra. Ample opportunity and assistance will be provided so the participants can become familiar with the use of the instruments and techniques for interpreting spectra of complex organic molecules.—Stevens Institute of Technology, Hoboken, New Jersey. Dr. Albert W. Meyer, Assistant Director of Research.

A Special Program of Extension Courses and Continuing Engineering Studies for the Construction Industry.—This program will acquaint engineers and managers in the construction industry with modern technical and modern management methods and assist them in applying this knowledge. The program will be devoted chiefly to applications of operations research, bidding techniques, venture analysis, project management and similar topics, but will also include special courses covering new developments in materials, construction methods, and other relevant technical subjects. Assistance in applying modern knowledge and management techniques will also be given the construction engineer and his company through a plan of continuing contact, over a three-year period, between the engineer and a Cornell engineering faculty member.—Cornell University, Ithaca, New York. Julian C. Smith, Director of Continuing Education, Carpenter Hall.

New and Expanded Graphic Arts Technical Services.—This program will expand the dissemination and use of science and technology in the graphic arts industry in the United States. The four projects included in this program are: (1) establishment of a newer technical information service to acquire, retrieve, and disseminate science and engineering information to the entire industry, (2) expansion of technical advisory services to provide a source of technical guidance by mail and personal contact, (3) expansion of technical seminars on new subjects and to new audiences that present services do not reach, and (4) expansion of technical information services to provide a steady stream of material on new subjects including lithography, rotogravure, letterpress, and other aspects of graphic arts technology.—Graphic Arts Technical Foundation, 4615 Forbes Avenue, Pittsburgh, Pennsylvania. William H. Webber, Executive Director.

Categories of approved STS activities by State programs

State	Seminars, conferences, courses, etc.	Information dissemination services	Referral services	Field services	Demonstration	Total
Arkansas	16	1	1	1		19
California	7	1				8
Florida	23	5	1	2		31
Georgia	6	3	2	4	1	16
Illinois	27	3		2		32
Iowa	19	4		2		25
Kansas	1	2	6			9
Louisiana	21	2	1	5		29
Michigan	53	1				54
Minnesota	9	3	1			13
Missouri	75	2	4			81
Montana	11					11
New York	29	19	12	1	1	62
North Carolina	23	6		3		32
North Dakota	11	1				12
Oklahoma	36	2	4			42
Pennsylvania	16	6				22
Puerto Rico	11	2	1	3		17
Tennessee	15	2	1	1		19
Texas	6	3	1	5		15
Utah	3	1	2	1		7
Virgin Islands	3					3
Washington	7	3	1	2	1	14
Wisconsin	5	4				9
Total	433	76	38	32	3	582

Mr. GROGAN. In administering the State Technical Services Act, we are learning many things about the utilization of scientific manpower resources. One of the premises upon which the STS legislation was founded was that the scientific and engineering resources of the universities could be brought to bear upon the major needs of American business and industry, thereby aiding in the overall economic growth of the Nation.

The modern university serves society in three distinct ways:

(1) the transmission of knowledge through the educational process.

(2) the generation of new knowledge through research.

(3) the application of knowledge through public service or extension.

The typical university is administratively structured and accustomed by tradition to education and research, the first two of its missions. Influences of structure and tradition are so strong in many instances that the university may not be capable of performing its service function in proportionate measure. There are some basic reasons for this prevailing condition that are worth mentioning.

Success in a faculty career at a university derives from a system that rewards the generation of new knowledge and its subsequent publication. The conventional system does not offer commensurate incentives for activities that encourage the application of new knowledge. The more knowledgeable and aspiring faculty member therefore turns his attention to the performance of research, usually under a Federal grant or contract. When performed well, this activity is followed by advancement, prestige, and related awards and inducements.

Programs specifically designed for the application of technology, as opposed to the generation of technology, typically do not provide corresponding opportunities for the practitioner to advance academically, economically, or professionally within the university structure.

Another barrier to the full use of university manpower as a resource to meet the broad social needs of our times is the traditional discipline orientation and departmental structure of the university. The problems of the real world do not manifest themselves in the neat packages or compartments by which knowledge is generated, transmitted, and applied within the university structure.

Economic growth through the application of science and technology, for example, requires the utilization of resources that range freely and widely across departmental lines. But this is admittedly the age of specialization. That specialization is necessary if one is to master the full depth of knowledge in any single field. The task before any technical services program, if it is to be successful, is that of bringing many technological specialties to bear on the identified problems in the broad sector being served.

While the concept of "technical services" in the sense of our legislation is foreign to the traditional practices of some institutions, we are beginning to experience a sense of awakening interest among many of them. Earlier this month, for example, Mr. Robbins received an inquiry from Dr. Irvin G. Wyllie, chancellor of the new Parkside campus, the University of Wisconsin. Dr. Wyllie is now engaged

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in the task of planning and developing a totally new major campus in the heavily industrialized southeastern area of Wisconsin between Kenosha and Racine. This campus is expected to open in 1969 and eventually will have a student body of 25,000. Dr. Wyllie expresses the belief that the Parkside campus must serve the region and the State by finding new and better ways of making available to Wisconsin industry the fruits of science and technology.

Dr. Wyllie's concern is just as great that the new institution also be able to serve the public sector. He seeks to determine at the outset how his bold new institution can both generate and participate in innovative services to all sectors of the community in which they are to be a part.

Since this is to be a totally new campus, Dr. Wyllie and his associates have a unique opportunity to design an institution that is not only attuned to the needs of our society but also is capable of working effectively in their service.

This single communication merely highlights comments that have been heard in recent months from both new and established institutions. Others, too, are searching for new institutional structure and mechanisms within the framework of the university that deal with public and social problems. There is a growing readiness among institutions to participate actively in the solution of these problems by bringing the best of their faculty resources into the mainstream of technology applications.

The State Technical Services Act as described here deals with the needs of the private sector of the economy—business, commerce, and industry. We are beginning to learn that these needs are different from the needs of the Federal R. & D. establishment.

In the same way, the scientific and engineering needs of local and State institutions—whether they be city or county governments, hospitals, school districts, or economic development authorities—are very markedly different from the scientific and engineering needs of either Federal R. & D. or the private sector.

Quantitative information about the transfer of technology is becoming available from a number of sources. The object lessons of these several researches should be equally applicable to all sectors of the economy and potential technology application.

The recently publicized study at DOD of major defense systems—Project Hindsight, C. W. Sherwin and others—comments upon the problems encountered in the useof new technology. Several evolving systems were fully explored and documented over decades, if necessary. Some of the findings of this study are immediately applicable to the subject of this hearing.

The Hindsight study shows conclusively that the application of new technical ideas requires that three major criteria be satisfied:

(1) There must be a well-defined problem,

(2) there must be an organized group of scientists and engineers capable of working on the problem, and

(3) sufficient resources must be committed.

Other significant findings of Project Hindsight that seem pertinent to these hearings include:

(1) Defense systems are built upon 20 to 30-year-old science, not new science. This would relate to the second point,

(2) that the continuing professional education seems critical and necessary if practicing engineers and scientists are to become familiar with and therefore apply the new science,

(3) defense systems involve the combination of large numbers of innovations, the aggregate effect of which often is greater than expected from the total of the individual contributions. They call this the synergistic effect.

(4) The systems approach to the design of defense materiel results in concepts and breakthroughs that would not have been possible if attention merely had been focused narrowly upon continued product development.

(5) The barrier to the transfer of technology in either direction between the industrial and military sectors is very great, although the reason behind this is not clearly understood.

Dr. Schon also mentioned this, I will reaffirm it here, that the pulling power of the market is a stronger urge upon technology transfer than the pushing power of the research documents. So, in connection with this point, I think we face the problem of finding the industrial needs, then determining how those needs then might be served out of existing or research information rather than starting with the data base in hand and going around trying to match that with industrial needs or, as your committee seeks, needs in the public sector.

(6) Finally, from the Hindsight study, they have observed that when technology does transfer between the public and private sectors, it tends to be in terms of large, well-developed pieces, such as a computer and its software equipment, or an aircraft or a system of management controls.

The Office of State Technical Services is taking the lessons of Hindsight, the experiences of both foreign and domestic organizations with similar missions and the current literature on the subject of our responsibility very much to heart. The problems of application of new science and technology manifest themselves in two principal audiences to be served:

1. Those who adapt belatedly to the full potentials of technological advance.

2. Those who are inclined never to adapt at all. This is not to deny the existence of a third group of pacemakers whose example we should cite for others to follow.

Thus, our services would tend to divide into two classes: (1) Technological updating for the users of new science and technology who fail to maintain pace with advances, and perhaps more generally and importantly, (2) general educational services to create greater awareness of the potentials for those who have fallen far behind the standards of their industry.

Moreover, the distinctions pointed out above as apply to specific industries also often have general applicability to communities, locales,

States, and regions. Thus, State technical services will differ in their content and methodology from place to place. We look forward to greater experience in this effort through continued association with the national program.

We are most appreciative of this opportunity, Senator Nelson, to represent State technical services before the Subcommittee on Utilization of Scientific Manpower. We should like to offer our further experiences to you from time to time in the form of reports, bulletins, and newsletters as they come out from our office.

Thank you.

Senator NELSON. Thank you very much, Mr. Grogan, for your very fine testimony.

Have you found that in the implementation of the State Technical Services Act that the State governments, in fact, do have adequately prepared personnel to effectively and creatively administer the act?

Mr. GROGAN. I think the personnel associated with the program are quite good, Mr. Chairman. We are a small program and we have not made great demands upon the personnel resources of the States at this time. I see it as a problem in the future, not only personnel in the State organizations, but more particularly in the university organizations who are oriented philosophically toward the type of enterprise in which we are engaged.

Senator NELSON. What was the effective date of that act?

Mr. GROGAN. September 14, 1965, the office was created mid-November 1965, and——

Senator NELSON. You really have not had a full year operation, insofar as the States are concerned?

Mr. GROGAN. Indeed not. The 600 activities which we funded in fiscal 1966 are in progress right now. I daresay no more than one-third of those activities have been performed and the others are being carried forth at the present time. We are in the process of approving programs based on the fiscal 1967 appropriation, there will be some lapse in time on these programs.

Senator NELSON. When will you have prepared your first report to the Congress on the performance under the act?

Mr. GROGAN. We will submit within the week our first annual report; it states what transpired through June 30, 1966. This has very little information on the performance, the use rate, the evaluation, the impact. We are expected to be evaluated by an independent committee within the 3-year authorization of the act. If this evaluation is to effective in our immediate future beyond the 3-year authorization of the act, I should think the evaluation would be performed within the next 12 months.

Senator NELSON. Who will make that?

Mr. GROGRAN. There will be a private committee set up by the Department of Commerce.

Senator NELSON. Of private citizens?

Mr. GROGAN. Yes; persons associated in no way with the program, in the administration at the Federal, State, or institutional level.

Senator NELSON. Thank you very much for appearing here today and presenting your fine testimony.

Would you care to add anything, Mr. Robbins?

Mr. ROBBINS. I wanted to make one comment concerning your question about the availability of resources of the States. From our experience I do not believe that the resources are lacking but that, depending on the State, adequate resources can only be brought to bear on our problems by certain people.

In other words, I do not believe that the full resources of all the States were available to work on many of our problems. This is partially due to the nature of the university, we believe, that we could not bring out the best of talents in some of the States. It is an interesting facet that Dr. Kimball's organization, Midwest Research Institute, for example, did the planning for a number of States. The States themselves did not feel they were qualified to do it and they called his organization in to do it for them.

Senator NELSON. Thank you very much.

That will conclude the hearings until tomorrow morning at 9 o'clock.

(Whereupon, the subcommittee recessed at 11:50 a.m., to reconvene at 9 a.m., Friday, January 27, 1967.)

SCIENTIFIC MANPOWER UTILIZATION, 1967

FRIDAY, JANUARY 27, 1967

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON SCIENTIFIC MANPOWER
UTILIZATION OF THE COMMITTEE ON
LABOR AND PUBLIC WELFARE,
Washington, D.C.

The special subcommittee met at 9:05 a.m., pursuant to recess, in room 4232, Senate Office Building, Senator Gaylord Nelson (chairman of the special subcommittee) presiding.

Present: Senator Nelson (presiding).

Committee staff members present: Stewart E. McClure, chief clerk, and William Spring, special counsel to the subcommittee.

Senator NELSON. We will now resume hearings on S. 430, Scientific Manpower Utilization Act of 1967, and S. 467, National Commission on Public Management.

Our first witness is Mr. Henry Rowen, president of the Rand Corp., Santa Monica, Calif.

We are pleased to have you here with us, Mr. Rowen, and we appreciate your taking time to come before us.

The last time you were here you were with the Bureau of the Budget.

Mr. ROWEN. That is correct.

Senator NELSON. Proceed, please.

STATEMENT OF HENRY ROWEN, PRESIDENT, RAND CORP., SANTA MONICA, CALIF.

Mr. ROWEN. Thank you, Senator.

It is a pleasure for me to be here today to discuss the "systems" approach to problems of public policy. The "systems approach" is being increasingly discussed and it may serve a useful purpose to analyze the essential features of this method and its applicability to our domestic problems.

In some ways there is a good deal more talk about this application than there is practice, and some of the reasons why there is more talk than action will be worth going into.

There is considerable evidence, for the utility of the systems method.

What is this method? In broad concept, it is quite simple. It implies taking into account all the factors that are relevant to a subject under study. Stated in this form, it sounds commonsensical, trite, but also, if taken literally, impossible to do in practice. Impossible, because everything in the world is connected in some way with everything else. But no finite amount of analysis can take account of everything

and whenever one draws a boundary, beyond which factors are to be ignored, there will be some influences, possibly important, left out.

Given this fact, we can eliminate at the outset one interpretation of the systems approach: that it is a method of understanding "everything" about, or even "everything important" about a given subject. That claim is misconceived.

One can learn a great deal about a subject, such as ballistic missile defense, child health, urban transportation, or population control, and be quite confident that some relevant, possibly very important, variables or data have been undiscovered, or neglected, or misinterpreted, or not given sufficient weight.

This being so, let's approach this subject from a different direction. Are there clearly important factors often not taken into account, or inadequately so, in the making of public policy decisions?

I think there is no question that this is the case. Just to mention a few examples:

The Federal Government spends about $1 billion a year on aviation, most of which is devoted to moving passengers from one airport to another as efficiently and safely as possible. But little effort is devoted to getting these passengers to and from airports—an increasingly important segment of the entire trip.

In the health field, Government spends a great deal on medical research to improve the health of the Nation. The budget which came out the other day shows a budget for biomedical research in the National Institutes of Health of about $1.3 billion, if I recall correctly. Of that total, my recollection is that something like one-tenth of 1 percent of the grand total is being devoted to improve the efficiency of delivery of services to the population as distinct from medical research, per se, for example, the search for a cure for cancer. A pretty small proportion.

Relatively little effort has been put forward to improve the performance of the system for delivering health care. Meanwhile, the health of this Nation, measured by various indices such as infant mortality, is relatively falling behind that of other developed countries.

To use another example, in urban transportation, our mass transportation and highway programs are managed as independent systems, despite the evident interaction among these two modes.

Now I think that most people would agree that decisions in areas in which interactions are strong should take account of these interactions. Doing this would be quite an advance, in many areas, but is this all there is to systems analysis? In my view, there is much more.

Perhaps the most useful, brief way to think about or to describe systems analysis is to regard it as a way of making discoveries. Discoveries not of things so much, but about objectives or values, or relationships, or facts. How does one go about doing this? There are several ways:

One way is to be as clear as one can be about objectives; that is, to try to be clear about criteria. If there is a valid generalization about a good systems analysis, it is that the analyst probably will help a great deal to clarify what the issues are, what various purposes are—or might be—served by the activity in question.

For example, elementary education teaches basic skills, instills habits of thought and behavior, excites interest—that is if it's any good—transmits factual knowledge, and gets the kids out of the house and off of the streets into the schools.

Any given educational program will contribute differently to each of these objectives and good analysis can clarify what objectives are really being served.

Moreover, simply thinking about objectives sometimes produces worthwhile insights, but trying to measure the extent to which a given activity meets various objectives is often more useful.

For although many important objectives may not be capable of being measured, we all can think of examples, the attempt to try is often rewarding. One might make a discovery. For example, the attempt to quantify educational attainments by giving tests may lead to discoveries about the adequacy of textbooks or the importance of the home environment in influencing the attitude of children toward school.

A second way is to attempt to identify as many of the important factors as one can, given the limits of time and resources, in any piece of research, and to describe the relationships among these factors as precisely as possible. A historical note may be of some interest here.

It was noticed by a number of research people, in the late 1940's and early 1950's, largely but by no means entirely located at the Rand Corp., that decisions on the design of bomber aircraft or their bases couldn't be made sensibly without taking into account the nature and performance of the air defenses that might be met, the peacetime and wartime location of bases, the vulnerability of these bases to various forms of attacks and the efficacy of various methods of defending these bases, the circumstances of war outbreak, the number and kinds of personnel, the target systems, and other factors.

A systematic effort to take into account factors such as these made a difference in the kind of aircraft it made sense to develop and buy. Whereas, formerly these factors had been generally known about, of course, there was no systematic attempt to look at all of these together—to design what we call now the entire system.

This approach has, by now, become the normal way to think about major decisions within the Defense Department. It also can be applied to narrower questions.

For example, the engineer designing the wing of an aircraft has to balance such factors as weight, lift, drag, fatigue life, and corrosion resistance. His "system" is the aircraft. He doesn't normally take into account the broader considerations I have just outlined, nor should he. If he did he might not have a very good airplane.

Now, I don't want to claim that casting one's intellectual net more widely solves all problems. It doesn't. It can produce superficial thinking. But it also can produce better designed aircraft and defense systems and, I believe, better functioning domestic systems.

A third way is to develop alternatives and to assess them. Examining alternative objectives and alternative ways to achieve a given objective is the hallmark of the systems approach. These alternatives need to be assessed both in terms of their effectiveness and their cost. Often, merely to figure out the cost of the alternatives is a substantial

contribution, even though the comparison of their effectiveness is too difficult to manage with much precision. People might end up having doubt feelings about what works better than something else, and if they can be illuminated as to what the costs are that is a good end quite often.

A good analyst is not attempting to make a decision; he is attempting to provide the appropriate decisionmaker with the alternative courses of action open to him, and their consequences.

Finally, a comment on the treatment of uncertainty. Although some aspects of a systems analytic problem may be sharply definable, measurable, and subject to experimental verification, usually important aspects cannot be so sharply defined. There is usually uncertainty in technology or behavior. It is of the essence of a good analysis that these uncertainties be explicitly taken into account.

Whenever one runs across a piece of work in dealing with the future in which a great deal of certainty is claimed, one should be very suspicious that the work isn't very good, that kind of certainty you just don't get in the world—even in technology, which is relatively the easiest to predict.

Exactly how they should be taken into account depends on what is at stake. At the very least, they should be stated. And it is very important that the researcher not claim more omnipotence in forecasting the future than he really possesses.

I would like now to turn to what is being done in this field in this country. First, in engineering, there has been a gradual extension of the scope of concern of designers. For example, chemical plants no longer are designed component by component and then fitted together in rough and ready fashion. Integrated, more efficient designs of entire chemical complexes, for example, are made at the outset.

The concept of integrated system design has, of course, been widely applied within the Defense Department. The Minuteman missile, for example, was conceived not just as a flying machine that would be provided with some separately determined kind of support, but as an integrated whole. Its manning, maintenance, basing, and control was designed jointly with the missile itself.

The Polaris system was similarly developed. More and more, the aerospace industry has been incorporating aspects of logistics, manning, basing, and maintenance into its systems designs. And, to repeat, the decisionmaking processes of the Defense Department have incorporated the basic principles of systems analysis I discussed earlier.

By now, each Government department, at the direction of the President, is adapting these techniques to its own needs. It is doing this initially, as is quite essential, by building up staffs within the departments.

This is proceeding at varying speeds and with varying competency among the departments as one would expect, but on the whole, I think the progress is really fairly good.

In times, it will undoubtedly become appropriate for these agencies to sponsor research and projects of various kinds by nongovernmental organizations. Even in the short run, outside groups are important as a possible source of skilled people for Government.

Within industry, perhaps, the most advanced in its understanding of systems analysis and design is the aerospace industry. This industry

has developed a wide range of analytical capabilities over the past two decades.

In technology their abilities are by now quite broad; however, in the social sciences, they remain rather narrow. Perhaps, and hopefully, in the years ahead the aerospace industry may find it necessary and desirable to become as broadly competent in the social sciences as it is today in the physical sciences.

You are not going to be sure of what is going to make this happen, but I think it is necessary for it to happen if American industry is to make a contribution to our domestic problems. Most industry is manufacturing, and it is just not yet clear what these companies are going to be manufacturing that will be of central importance to a lot of our domestic problems.

It has been suggested recently that perhaps they should be manufacturing housing in a technologically superior way, and there are possibilities of that kind, but a lot of our problems are not problems of manufacturing.

There are very tough problems—society problems—and it is not altogether clear what is is that is going to move aerospace or other industry to acquire the competency to make major contributions to these problems.

In short, I believe that private industry can do a very great deal to help solve some of our domestic problems. The flexibility, drive, and management competency of the better managed firms in this country can make much more significant contributions than has been realized so far.

One of the more important challenges facing the Government today is to figure out how to use this talent and energy in the private sector. But one should not expect the marketplace to solve all of the problems. When one is dealing with important social interactions or spillover effects as, for example, when my automobile exhaust becomes your pollution problem, the market mechanism usually doesn't work very well. In these cases, a major role for Government is inescapable.

Another potential major resource is the universities. Universities have in their faculties an extraordinarily wide range of skills, and many of these skills are directly relevant to such problems as education, health, poverty, and urban affairs.

Moreover, many university people are interested in social welfare problems and want to help. And many do help. Some as individuals working in their communities, some as consultants to governments, some by doing academic research either as separate researchers or in policy-oriented academic centers.

The principal problem they face in being effective contributors to the solution of these problems is in getting multidisciplinary research done within the university environment. For public problems frequently cannot be satisfactorily analyzed by a person trained in a single discipline. Problems just don't come out that way.

Teamwork is important and teamwork is notoriously—and with good reason—difficult to arrange in the academic community. For universities have, as an essential feature, individual research and teaching. Collaborative work is being done increasingly, but it is an uphill struggle in many areas of academic interest to get collaborative work done.

Universities can make an especially important contribution to the problems of State and local governments. Ties exist in many cases and these ties can be strengthened and made more useful to these governments.

But there is so much to be done at the local level. State and local governments simply do not have the research and planning traditions of even the Federal Government—which itself is woefully weak in many areas. This fact contributes substantially to one of the more important dilemmas confronting the American governmental system. Perhaps it is in some respects these central dilemmas, if that is not overstating it.

Washington attracts able people who are able to operate in a relatively advanced managerial environment; but Washington, being far from the grassroots, is seriously limited in its sensitivity to local issues and data.

Local government is near the people and the problems but it lacks many of the attributes of effective government. Many local units are poor and certainly many are small. This dilemma is real. I think there are formidable obstacles to major improvement. But many local governments are able to afford and should undertake, a serious effort to modernize their systems. And some are. For example, several States within the last year have decided to adopt systems similar to the planning, programing, budgeting system adopted by the Federal Government a little over a year ago, and many others are interested in doing so. As the more advanced State and city governments improve in this managerial competency, they will then be better able to use help by outside organizations, private and public.

Finally, a word about new institutions to help with these problems. We clearly need some—governmental and nongovernmental, profit-making and not for profit. I am not prepared to lay out a grand design for the country on this subject, but there are a few features that seem to me to be essential in whatever is done. One is diversity. There should be no single approach to working on these problems and I feel confident no single approach will be adopted.

Many kinds of institutions, many disciplines, many techniques are needed.

A second is continuity of effort. Problems of education, poverty, and the urban environment are not easy. They are terribly complex and real progress will not come quickly. What is needed is a well-designed and imaginative program for continuing study both at the "fundamental" and "applied" levels, of the problems that our society faces.

The goal of the "systems approach" is to provide techniques that indicate the next step to take in order to surmount a complex and pressing public problem. Typically it is not possible or prudent to attempt to solve these problems in one giant step.

The "systems approach" adopts the view that research, quantitative analysis, experimentation, and above all imagination can contribute to an orderly program for successful resolution of public policy questions.

That concluded my statement, Mr. Chairman.

Senator NELSON. Thank you very much, sir, for a very fine statement.

As you are aware, there are two bills pending before the committee, one of them proposes creating a commission, the main objective which would be to evaluate how to use the concept of systems analysis; and another bill which proposes to allocate funds to the Secretary of Labor and authorize him to make grants and contracts to Government, regional planning commissions, various groups for the purpose of implementing the use of the concept of systems analysis.

I do not think either of these bills in their present form really are the best approach to this problem.

The bill that came out of the hearings I originally conducted at which you appeared then as Budget Director really is following the concept used in the planning grants, the 701 planning grants, which means—I think they have been remarkably successful in inducing governments at all levels around the Nation to move into the planning field but that is a much simpler proposition in many ways because planning is the same all over in a general way; if you are going to do a comprehensive State plan or comprehensive regional plan the format is quite similar.

So, in conducting these hearings we are trying to get some ideas about how to draft a better bill which would, by the use of as your suggested nonprofit organizations, who would be involved in the field of systems approach, by the use of governments and regional groups to help induce the application of this approach to social problems.

Do you have any idea——

Mr. ROWEN. I think I could make a few observations.

You will note in the budget that came out a couple of days ago, if one reads it carefully, a number of references to funds being provided in several quite important domestic agencies for the purposes of analysis, evaluation, research. The terms differ slightly from place to place.

These funds are put in fiscal recognition on the part of these agencies and the Office of the President that much more needs to be done to do a decent job on these problems.

For example, in the Department of Housing and Urban Development, $20 million has been allocated for the purposes of urban research. This is a real departure for that Department. It has never had a serious research program.

In the Department of Health, Education, and Welfare, a substantial amount, I cannot recall the total, has been put into the budget for the purpose of evaluation, not just research in education or health in general, certainly not biomedical research in this instance, but research in the programs, and the same is true in a number of other areas.

Now, I think this is going to be a big step forward. I believe it has left open the extent to which this work would be done in-house, to what extent it would be done outside.

I believe, for example, in the case of the Office of Economic Opportunity that substantial sums have been provided for analysis, evaluation of community action programs in communities, at least the principal cities, so this clearly would be done at the local level.

Now, this approach has the considerable merit that it is tied to the program interests of the departments involved.

It also has the merit that at least in some of these cases a lot of the work is going to be done at the local level, which is just terribly important.

Now, proceeding in this way I think that one will see the strengthening of institutions which in some cases will undoubtedly be universities that will be doing much of this work, in some cases not for profit firms, research firms by and large, perhaps some new organizations. I don't know what is going to happen, but I think this is a very good way to proceed, at least at this stage—to have the Federal agencies who are concerned with these programs, concerned with these areas of education, housing, and what have you, doing much more to stimulate analysis and research in the areas of their program interests.

I think other things might be done. At least one other approach is worth thinking about very seriously, which I think would be complementary in connection with this. This would be to provide the States, possibly the bigger cities as well, but certainly the States, with block grants—and this may be really what your bill is intended to do—for the purpose of giving the States some resources with which to work to this end. It is true that many of the funds they get are earmarked. They fall into traditional channels: They go to the State department of health, or the State department of education, where there isn't much of a research tradition to begin with.

Certainly the kind of planning that goes on for the most part is really pretty miserable; where the availability of funds to build some institutions either within the government or outside tied to the government are really very limited.

To go, as I did last year, to the State of Michigan, where there is great interest on the part of the State government in doing something comparable to what the Federal Government is doing, look at the resources they have available to delploy, build something in the Office of the Governor, say, or the budget bureau in the State of Michigan.

It is just a very difficult situation. Most State governments are really strapped for money. They do not really have enough people who can be mobilized to form a research unit within the government. They do not have the resources to do it. It is an uphill struggle.

I think considering these obstacles they are doing very well, but it is not easy. I think this is true in many State governments. I think it is true in even as wealthy a government as the State of California. They are feeling rather pinched at the moment. They clearly have resources far above most State governments. Pushing money on people, as we know, does not solve problems and can lead to the money being wasted. But I think it can be done in a way that makes it very clear this is not money to be frittered away doing more of the same old dreary things, but is to be devoted to building some decent institutions, or converting institutions and making them better.

The former I am clear on, to have the Federal agencies with program responsibilities getting more, that is clear.

The second approach—which I gather is more nearly related to your bill and is, I think, worth serious consideration—might accelerate the rate at which all of this will happen.

One other observation I would like to make: I am struck by the difficulty that local government has, particularly the medium-sized

cities and smaller, and the smaller States for that matter, in having each independently to "discover the wheel." That is, each government, each jurisdiction, has to worry about not only extraordinarily difficult and subtle problems of what's the proper kind of educational system to have, how to design the city and make it a more livable place, but much easier problems, such as how to remove snow, how to collect garbage, how to keep the street clean.

If one looks at how these jurisdictions get at these problems, both the tough ones and the not so tough ones, one observes that by and large, except for the existence of professional societies and a certain amount of technical work that is gradually diffused, they have to operate pretty independently. There are not many places around the country where they can turn to and say, "By God, this is the best way you get snow removal."

It sounds like a trivial problem, though one knows it is not so trivial in the Midwest today. It is not a trivial problem. A lot of money goes to schools and housing—including public housing—and it is very tough for any jurisdiction in particular, if it is a small one, to figure out what is the best thing to do. It just doesn't have the staff people to do this sort of thing.

Last year I helped to encourage a group of students at MIT to work with the city government of Newton, Mass., to do some rather simple but very useful analyses of some of the problems in the community, with the idea that if they did good work it might have very general applicability for a large number of communities, say, of the population on the order of 100,000, which is the population of Newton.

We do not have many institutions—rather we don't have any—to design work on problems, to work on solutions that might have wide applicability around the country. They needed to act as a focal point not only for getting the problem solved—to the extent it can be solved—but also to develop somewhat better practices than we currently have, and get the word around.

Senator NELSON. Would it not be feasible in approaching this problem to create a national commission, of the right kind, I will not try to describe it, have that commission consult with a variety of profit and nonprofit groups who are engaged in systems approach to problems?

Mr. ROWEN. I think maybe it would.

Senator NELSON. And I will continue, and out of that identify with them a number of problems that are of significance and common to a number of jurisdictions of one kind or another.

You mentioned cities. Why would it not be feasible to identify a number of problems and then take groupings of cities in the 100,000 class, half a million class, each one of them has a different capacity to hire planning people, and then is it not probably true that you can identify a number of problems that are the same and the solution would be roughly the same for other cities their size around the country, whether it is snow removal or traffic management problems or whatever it may be, and then select cities of various sizes and then do a systems approach to this particular problem and then this knowledge becomes made available to all other communities of roughly the similar size with the same problem?

Would that have value?

Mr. ROWEN. I think so, particularly if they were to concentrate on the question of the adequacy of our existing institutions and how it would be to make them more useful or to create some new ones. I do not think the principal problem is finding interesting problems that need to be solved.

The list is extraordinary long already, of researchable, important, public policy problems where a lot can be done. I think it would be worth their doing that simply perhaps to dramatize it but it would not take an enormous intellectual effort on their part to do this.

I think in a way the much more difficult problem is to figure out what kinds of institutions are needed. To what extent should one try to create academic centers? Some may exist. Should they be built up? Should resources be put into universities with the idea that the universities become the principals?

In my statement I said that there is no one approach. Even so, there may be some areas of emphasis that are more interesting than others. Should universities really become the principal focal point for work of this kind? Perhaps so. But if so, what is it going to take to make the universities more effective than they have been so far?

This would be a useful thing for them to look into. If not universities, or if in addition to universities, what other kind of institution?

I am made conscious of this in going around the country. In the city of New York, for example, in the State of New York, in the State of California, the recurring problem is: Who can we turn to to get help? Who can we look to? We cannot do it in our Government right now because we don't have the people, we don't have the skills. Where can we find these skills? Who can we look to?

And if this were the major focus, or at least a major focus of such an institution, I think it might serve a useful purpose.

Senator NELSON. I think we can place some considerable emphasis on the fact that there is a shortage of expertise in the field we are talking about, but in drafting a piece of legislation it is not practicable, really, for a Congress to outline a detailed pattern of what ought to be done here. This was why I was suggesting that perhaps with a commission authorized to consult with all of the variety of experts there are in private and nonprofit organizations and universities to identify the best approach to take to make a useful contribution.

Out of that I would assume that one of the first points that would be raised is that we have to train some people. Then where is the best place to train them? What is the best approach to do that? And, what is the most effective way to start transferring to the local level the capacity and the philosophy and the understanding of this concept.

Mr. ROWEN. That sounds like quite a good thing to do. Very sensible.

Senator NELSON. I appreciate very much your making this very fine contribution. If something occurs to you that you omitted to say that would be of value, I would hope you would send it to us. I think everybody who has appeared agrees that the systems approach, properly used, is a very valuable device in solving many, many prob-

lems, but the question is how do we most effectively expand its use and give other units of government capacity to use it and the understanding of its importance. That is what we are concerned with here.

Mr. ROWEN. Very laudible. Thank you.

Senator NELSON. Thank you very much.

Our next witness is Prof. John Geyer, Johns Hopkins University, Baltimore, Md.

Professor Geyer.

Professor Geyer, we appreciate very much your taking time to come over here and appear before us today. Senator Javits from New York and Senator Clark and Senator Dominick each had some requirements in other committee areas which made it not possible for them to be here, but we are pleased to have you come and if you have a prepeared text it will be printed in full in the record.

You may proceed to present your testimony as you wish.

STATEMENT OF PROF. JOHN C. GEYER, JOHNS HOPKINS UNIVERSITY, BALTIMORE, MD.

Mr. GEYER. Fine, thank you, Senator Nelson. Do you want me to identify myself?

Senator NELSON. Yes, for the record.

Mr. GEYER. I am John C. Geyer, professor of environment engineering at the Johns Hopkins University, Baltimore, Md.

Senator NELSON. Go ahead.

Mr. GEYER. Fine.

Senator Nelson, my comments will be confined to matters related to your questions about the "systems approaches" to our most pressing domestic problems.

These questions are: (1) What is now being done? (2) What should be the role of the various governmental and private agencies and institutions? And (3) what new institutions are needed?

It is indeed a pleasure to endorse the types of programs which Senate bill S. 430 would make possible. This application of systems approaches using high speed computation and a variety of simulation devices, promises a giant step forward in the appreciation, the analysis and the solution of the great sociological and environmental problems of our times.

It is understood that these "systems analyses" will be supported by vastly increased programs for collection of basic data and for working out, also with the same computers, the interelationships between all the factors and phenomena at play.

In order to analyze these complex systems we will have to learn more about what goes on within them and how they respond to perturbations and changes. This process is another endless cycle, for one is never sure what questions to ask or what measurements to make until a system is analyzed. But the analysis cannot be complete until the necessary data and understanding are in hand. Analysis and data gathering must proceed together. Usually, the getting of the facts and the understanding is going to be much more laborious, costly and time consuming than the making of the "systems analysis." The latter is the payoff following a lot of very hard work.

In earlier testimony, when Dr. Culver was discussing the California waste management study made by Aeroject General Corp., he pointed out the difficulty and high cost of a feasibility study. This initial step in a systems approach to the environmental pollution problem was estimated to require 3 to 5 years and cost $8 million to $10 million. He pointed out that final costs and time spent on the feasibility study would depend upon other research and development programs being conducted by the State and Federal Governments to provide fundamental information to define the problem.

It is assumed that he includes in this step the research and development needed to understand the behavior and response of the systems involved and to develop the means for effectively controlling such behavior. This initial step must, according to Dr. Culver, be followed by a preliminary design, a detail design, an acquisition phase and then system operation. I would add another step, it would be a followup evaluation of performance and accomplishment so that future systems analyses can be based on much better information and understanding than we now have.

WHAT IS BEING DONE NOW

Most of the interest in and use of systems analysis approach in the areas named in the bill has been at educational institutions or in private agencies.

Through activities, primarily at Harvard, there have been significant advances in the application of systems approaches to water resources conservation and development. Studies of the Indus River in Pakistan and the Delaware River Basin followed the early work at Harvard.

In recent years, several educational institutions have begun to teach and do research in applications of systems analysis to environmental problems. Application of operations research techniques to civil engineering problems has grown rapidly.

In the sociological fields and in the area of urban problems, the two being almost synonymous, application of the systems technology appears to have been much slower. There are probably two reasons for this.

First, cities do not have the money or the personnel to undertake such studies and second, measurement, quantification and understanding of the forces at work in cases where human behavior is involved are many times more difficult than in the world of physical things.

There can be little doubt, however, that in all fields covered by S. 2662 there is a great deal to be gained by greatly expanding the application of systems approaches. The sooner that advantage is taken of this opportunity, the wiser will be the use of our money and resources.

ROLE AND RELATIONSHIPS

The Federal Government is certainly in a better position than anyone else to stimulate and support programs designed to mobilize and utilize the scientific and engineering manpower of the Nation. This is particularly true in the case of rapidly developing technologies such as the application of systems analysis approaches to complex social problems.

The bill would provide money to the States for the kinds of studies being discussed. This is a very good way to provide support for three reasons.

First, it provides decentralization which always seems desirable.

Second, it brings the State into areas of research and study which have been neglected at the State level.

And third, it assures that the Governor and his agencies know what is going on and can participate in and take full advantage of the work.

The question then must be raised as to what the State should do with the money. It should do many kinds of things depending on the urgency of problems, the nature of the situation, and the needs and desires of the people involved.

There are complex systems at all levels of living and government. The dwelling unit is a system, and so is a housing development with its services and amenities. There are problems to be studied and systems to be analyzed at the neighborhood, the city, the county, the district, the metropolitan and the State level. Much special research must be done and many people need to be trained in different ways.

The States should be encouraged to use the support in any of a wide variety of ways designed best to promote the use of systems analyses in attacks on any important public problem. Education and training might be promoted by establishment of fellowships, by development of inservice training programs or by sending personnel to school.

The research needed to supply facts for the analyses could be carried out by an appropriate government agency or could be done through grant to or contract with public or private educational or research institution. The actual systems analyses might be by a central group or they could be farmed out as best suited any situation.

The objective of all these activities would be to take maximum advantage of all available talents and institutions in a concerted effort to use systems technology to understand and come to grips with problems of modern society.

I would put no strings on what a State might do with the money except that (1) the activity supported contribute to the application of systems approaches and, (2) the results be made available for the use of others. I think this would come closer to optimum utilization of manpower than any other way of going about the job.

Senator NELSON. May I interrupt for just a moment?

Mr. GEYER. Yes, sir.

Senator NELSON. You would make grants to the State government. Who would carry on the program of training, for example? How would you do that?

Mr. GEYER. It would seem to me that the State would have to organize its own internal resources and develop a program and seek support of this program, and it might involve giving fellowships to private or public institutions to train people for State service or for service in this field, or it might go to industry for certain kinds of studies or to private research laboratories.

I can visualize that there are a great many ways in which the money might be used to advantage and, of course, the State, when it applies for the money, would have to indicate what kinds of programs, what kinds of things it hoped to do.

Senator NELSON. Is there adequate personnel within the State governments with an understanding of the nature and character of the problems so that they could effectively spend the money?

Mr. GEYER. No, I address myself to that point in a moment here. There is just a little more left and I will finish it and come back to this.

Senator NELSON. Fine.

Mr. GEYER. Most States do not have any management obligations relative to municipal services such as water supply, waste disposal, air pollution control, drainage, metropolitan transit and the like. Improvement of the management of these public services is a prime area for application of systems analyses. It is to be hoped that money going to the States could be passed on to cities or to any other appropriately constituted group for making systems studies of their problems.

It has been pointed out in earlier testimony that we need to know the boundaries, the interfaces, the inputs to a systems and the outputs from it. It is necessary also to understand (1) the system from which the inputs arrive, (2) the interrelationships within the system itself, and (3) the effects on the system which receives the output.

It will not be sufficient to assume an unalterable input. For example, in working toward a solution of most industrial waste problems, industry must first look back at what it is doing in the factory. Process and product changes, waste reduction, improved operation, byproduct recovery, and better housekeeping are all important measures for pollution control. What goes on in the factory is a part of the system and must be studied. The States will undoubtedly recognize this and through support by this bill may be able better to lend a hand.

NEW INSTITUTIONS

Then turning to the question of new institutions, it is difficult, if not impossible, to foresee the kinds of institutions and institutional arrangements which will turn out to be most effective. Every State is different and has somewhat different problems.

Individual capabilities and interests of people are more important for success than is the kind of institutional arrangement. This being the case, it seems to me desirable, in respect to institutions, to leave the matter up to the States.

There will certainly need to be a highly competent group somewhere in the State organization that can help plan the systems analyses and see that the money goes to those problems and studies where the need for help is greatest and the chances for accomplishment most promising.

One possibility might be for a State Governor to have an office of science and technology supported by a science advisory group just as is done at the Federal level. This might be a very significant step toward prompt application to public problems of all the great scientific and technological accomplishments of the last two decades. If such offices were established they would be ideally suited for the stimulation and administration of a program to accomplish the objectives of S. 2662.

The space age technological accomplishments, in particular high speed computers, will make it possible to study large and complex

systems in quite sophisticated ways. The decisions will be the better for this and much waste of effort will be avoided in action programs which follow. The time required to reach the desired goals will still be long, but the way is sure to be surer.

Senator NELSON. At Johns Hopkins you have a graduate program in operations research, is that what it is called?

Mr. GEYER. We have a Department of Operations Research. This used to be the Business Department in the Engineering School, but there are many different groups in the university which are doing systems analysis and operations research type of studies.

My own department is the Department of Environmental Engineering Science. We have a new man, very expert in this field; he has a computer console right in his office connected to a computer here in Washington. The students use this and he uses it. He is already getting support—in this case from the Public Health Service—for systems analyses studies of solid waste disposal systems. He is getting support in the form of a training grant to train people for this kind of work. I don't know how many consoles, for example, there are at the Homewood campus but I understand about 20 are now in different departments.

Senator NELSON. What is the situation in the academic institutions in this country in terms of programs of the nature that are being carried on at Johns Hopkins with the objective of training systems engineers?

Are many institutions engaged in this now?

Mr. GEYER. Well, they are very rapidly becoming engaged in this kind of activity. Some of the schools, for example, I know that Harvard, Cornell, Northwestern, and the University of California, have all been in this area for quite some time and many of the other schools are getting busy as fast as they can.

Senator NELSON. Is there any national register anyplace where we would get a list of the schools in the country that are engaged in training systems——

Mr. GEYER. Not that I know of. It would be useful to have such a list.

Senator NELSON. We need an analysis to find out what is going on in institutions.

Mr. GEYER. Exactly.

Senator NELSON. How do we find out what institutions are doing? Just travel through the academic world and bring them out?

Mr. GEYER. No, I am sure that there are various associations of university administrators and of professors in the academic field, which could find this information out very quickly. I do not know that it is not available, it may be available but I just do not know of it.

Senator NELSON. In training people in systems analysis, systems engineers, whatever you wish to call them, what kind of program is it? What factors go into academic programs for training systems engineers?

Mr. GEYER. Well, we are taking the approach that we are training in my particular case, environmental engineers, sanitary engineers and biologists and people who are going to work with pollution problems and water supply problems, and waste disposal prob-

lems. We are teaching them the systems approach to these problems so that they become systems engineers or systems oriented themselves.

Senator NELSON. So, they are not only technically and academically qualified in the specialty but they also have some additional education that teachers them the systems approach to the particular specialty in which they are being trained, is that correct?

Mr. GEYER. That is right, sir. In order to study a systems analysis approach to a problem you have to study a problem. Now in our case, the problem is environmental control. Over in what used to be the industrial engineering and now is operations research, they apply it to all kinds of industrial problems. And in electrical engineering the systems approach is applied to all kinds of electric systems with which they are concerned.

Senator NELSON. In your environmental program, are you educating people in a large number of aspects of environmental problems—air, water, ecology, all of these?

Mr. GEYER. That is right. We have two biologists in our department who are cooperating with other biologists in the university to develop studies of the type that you are talking about, the effects on ecology of natural waters, of pollution. The department is primarily oriented toward water problems, we do not have an activity in air pollution, for example.

Senator NELSON. And then when your students have graduated where are they going? I know they will go a variety of places, but where do they expect that their talents are going to be used?

Mr. GEYER. The students that we are most proud of—Dr. Pierce Linaweaver was offered a very fine job with the IBM Co. to set up a systems approach to a water resources problem in that company, but he received a White House fellowship and is in Secretary Udall's office.

Most of our doctoral candidates have gone into teaching. Some of them are in charge of the Water Pollution Control Administration laboratory activities, some of them are involved in the new water resource research institutes and centers set up by Interior in each of the States.

I did not bring with me a list, but they are all in very important positions, primarily in the academic field. This is a problem, there is such a great need for trained people to get new programs started that very few of them in our field, at any rate, get out into practice yet.

Senator NELSON. Back to the suggestions you were making about allocations of funds to State governments. I would guess that it is probable, assuming Congress were willing to support some proposal for the Federal Government to become engaged in this field of aiding regional planning commissions and States and cities and various groups in developing expertise and understanding in the field of systems analysis, I would guess that it is unlikely that—this would be just my guess—they are going to be willing to fund for it with activity in 50 States at once.

What we are seeking to do as the bill is drafted, is to constructively tackle the problem and at the same time have it acceptable to the Congress, and it has been suggested and discussed some this week that there might be created a national commission, I will not attempt to identify how you create it, but assuming there was the right personnel,

and that through this that you would authorize this commission, for example, to contract with profit and nonprofit groups and individuals in universities, in the nonprofit organizations that are doing planning and systems analysis now, as well as the profit ones, and then attempt to identify some the best way to tackle this problem and then give grants in that fashion.

I suppose, I am sure that out of that all of the problems that you have raised here and others raised here would be brought up—the shortage of training personnel which would, I assume, indicate to the commission that there ought to be some funding or assistance in this field, and since we are going to be dealing with live, active institutions and State and local governments, with the personnel who are already there, that it probably makes good sense to set up some kind of training program that they could participate in.

Mr. GEYER. Yes, sir.

Senator NELSON. Maybe send their budget director and various others from their agencies and departments to some courses—3 months, or whatever we think feasible——

Mr. GEYER. It would be highly desirable; I am sure that they would jump at the chance to do this kind of thing.

Senator NELSON. Now, could you take a budget analyst, whether he be out of the department of public welfare or out of the budget bureau of the State or anybody else who is in the planning or management side—are we prepared in any of our academic institutions to take some of these people and give them a course of 3 months or so that would be of value? We are not expecting to make systems engineers out of them but at least what we have to do is demonstrate to a number of people in the appropriate areas the value of systems analysis so that they will have an idea of how it ought to be approached.

Could you do something in the academic institutions in 3-month courses?

Mr. GEYER. I think some are already doing this and I am sure others would be delighted to cooperate in this kind of activity. I do not believe there would be any problem at all in doing this. If there were some central group that were stimulating it and encouraging the public agencies on the one hand to send their men and helping the university with the financial problems that are involved, the program should be successful. You probably would not want to make programers out of people like this but they should know enough about how computers work to appreciate what can be done with them, and this may involve actually some use of computers.

All our students now work their problems on a computer, not that they could not work the same problems otherwise, but they do this as a training mechanism.

Senator NELSON. Have you had the opportunity ever to examine any of the work being done by the various regional planning commissions around the country?

Mr. GEYER. It has been some time since I have been involved in any of these activities. I know of them kind of by hearsay but not by direct involvement.

I know that they are concerned with regional problems much more today than they have been in the past because it has become apparent as metropolitan areas spread across so many jurisdictions that the solutions cannot be found by any single jurisdiction.

Senator NELSON. It has also been suggested here that it might be possible to set up by region some teams of systems analysts who would be available as advisers, consultants, and so forth, in areas broader than one State.

Does that idea seem to have any validity?

Mr. GEYER. I think when the problem crosses State boundaries it is almost necessary to do this. There is no point, really, in studying air pollution in Manhattan unless you look at what is going on in New Jersey and Long Island and pretty soon may be you will have to look at what is going on in Philadelphia and Baltimore to see what the effect on the character of the air is on up the line. Regional studies are very desirable.

Senator NELSON. I appreciate very much your excellent testimony and appreciate your taking the time to come over here and give us your help this morning.

Mr. GEYER. I thank you for the opportunity. It has been a pleasure.

Senator NELSON. Thank you.

We will take a 5-minute break for the reporter.

(Whereupon a brief recess was taken.)

Senator NELSON. Our next witness will be Prof. Kathleen Archibald, assistant director, Public Policy Research Organization, University of California at Irvine, Calif.

Professor, we appreciate very much your taking your time to appear before the committee today.

You have a prepared text, do you?

STATEMENT OF MISS KATHLEEN ARCHIBALD, ASSISTANT DIRECTOR, PUBLIC POLICY RESEARCH ORGANIZATION, UNIVERSITY OF CALIFORNIA, IRVINE, CALIF.

Miss ARCHIBALD. Thank you very much, Mr. Chairman, for the opportunity to appear before the subcommittee.

I thought I would just summarize the main points of my statement in speaking before you. I think probably the two points that may be of most interest in connection with the Public Policy Research Organization at University of California, Irvine, are——

Senator NELSON. What does that mean, by the way, "Public Policy Research"? What is the area—everything?

Miss ARCHIBALD. In general, what we are talking about is an interdisciplinary, systems approach to problems of public policy. By this we mean a careful look at the alternative choices in public policy, including the reformulation of policy problems and possibly the invention of new alternatives. So, in other words, generally, systems analysis and, in particular, systems analysis as that term has been used by the Rand people.

In terms of the areas we plan to work in, this is open at the moment—primarily in domestic areas. We also expect, though, to do some work in international security and international development.

I am afraid I cannot give you information derived from prior operating experience because we really are just beginning to get going, but in planning the organization——

Senator NELSON. This is one department within the institution.

Miss ARCHIBALD. Right; it is not connected with any particular academic department, it is an all-campus organization and actually our charter suggests we also draw on faculty resources from the other campuses of the University of California, so in that sense we are all-university as well as all-campus.

Senator NELSON. You may read and/or extemporize, proceed as you would like to do.

Miss ARCHIBALD. Fine; I think I will start by reading and shorten it somewhat.

People interested in the problems and potentials of policy-oriented research have often noted that there may be a need for new organizational forms to encourage and conduct such research and to aid in the dissemination of its results.

For instance, this was mentioned in the Bell report, prepared by the Bureau of the Budget several years ago; it was also mentioned in the testimony before this subcommittee in May of 1966.

What may be of particular interest to you is the fact that the public Policy Research Organization is a new kind of structure. It differs from other existing research organizations in several ways. It is a hybrid, falling somewhere between the traditional university research institute and the nonprofit advisory corporation.

It has two primary objectives: (1) to undertake long-term programs of policy research and analysis in several substantive fields, such as, education, international development, and social welfare; and (2) to establish educational and training programs in the field of policy research and analysis. The training program will be connected both to the academic curriculum within the university and to ongoing policy research programs within the Public Policy Research Organization.

I mentioned earlier what we mean by policy research and analysis, so I won't go over that again. I might add, however, that there is a problem of lal eling. The field is still young enough that people use different labels to refer to it, or sometimes the same label to refer to different things. I noticed in listening to Professor Geyer's testimony that he was referring more to what I would call systems engineering and I think a distinction can be made between systems engineering and systems analysis. Systems engineering is a much more established field. For instance, I will mention later some of the questions we have about how you train people in systems analysis or policy research, whereas in systems engineering they know how to train people and they have been training systems engineers for some time. The more social science side of the systems approach is a newer field and it is a little bit more difficult to see how you should go about training.

This brings me to another point of difference between PPRO and existing organizations. This is in the approach we hope to develop and the way it will differ from at least the past work of existing organizations. The disciplines most involved in the development of systems analysis have been economics, engineering, statistics, and, to a somewhat lesser extent, mathematics and some of the physical sciences. The social sciences, other than economics, have been very little involved in the systems analytic approach although they have

been developing their own distinctive approaches to applied work, particularly to practical problems at the level of the community and smaller groups.

We hope it will be possible to develop a better articulation between systems analytic approaches and the social sciences, since the special expertise of, for instance, sociology, anthropology, and social psychology, seems to be particularly relevant in understanding and coping with many of our domestic problems.

To give you a little background on this program: The idea of establishing a new kind of structure to conduct policy research and analysis developed out of a feeling shared by many people within the University of California that the university had both increasing opportunities and increasing responsibilities to provide expert advice on public choices between and among policy alternatives.

Ex-President Clark Kerr set up an ad hoc committee, composed of faculty members from all campuses of the university, to explore the desirability, feasibility, and possible design of a policy research organization. In his letters of appointment to committee members he stated:

> A structure for policy research should be complementary to, rather than competitive with, the teaching and basic research functions of the University. It may need to be quite different from our usual research institute in its relations, both to the world outside the University and to the people within the University. At the same time, it should be designed in such a way that it can help and not hinder the research of individual faculty members and the education of graduate students.

This committee was chaired by Roger Ravelle, who is now at Harvard and was then the dean of research at the University of California, and I served as a senior staff member to that committee.

What we set out to do was first to attempt to establish the conditions that have facilitated the conduct of policy research and analysis by looking at the past experience of other organizations. We looked at programs that had been successful, and programs that had been unsuccessful, and tried to account for some of the differences.

We paid particular attention to the nonprofit research corporations which had established the field of systems analysis and had done the best work in the area. The preeminent example here seems to be the Rand Corp.

We then looked at the problems of conducting this kind of work within traditional university structures. Finally, we attempted to design an organization that would be linked closely to the university but would also reflect some of the best features of the nonprofit corporations.

I will outline the basic requirements we identified as being important to the conduct of good policy research, and then mention some of the difficulties we felt would be encountered in meeting these requirements within a standard university setting.

1. Independence. Independence for a research organization is important to best serve the client's needs, to obtain a good staff and maintain their interest and morale, and to contribute to the long-run welfare of the Nation.

Independence is not simply the freedom to tell a client something different than he wants to hear, nor is it necessarily the freedom from

having any client. It is the freedom to say "No" to some jobs and some clients and "Yes" to others, as well as the ability to initiate research when no client is currently interested in supporting it.

It should be mentioned that having independence is not quite enough, a policy research institute also has to be seen as being independent, to have an image of independence.

2. Stability. Systems analysis or policy analysis has been at its best when performed within the context of a long-term, continuing research and advisory operation. People from different disciplines have to learn how to work with each other—or, perhaps more accurately, whom they can work with. The organization has to develop some depth of expertise in its areas of specialty. A working relationship with appropriate policy and operating agencies has to be developed; and decisionmakers have to develop their own methods of utilizing analyses. All this takes time. The one-shot project is seldom much help to anyone. Thus, a policy research organization under ideal conditions should have the kind of stability needed to think in terms of 5- or 10-year programs in particular areas.

3. Flexibility. Probably the most essential aspect of flexibility is being able to modify the size and composition of the professional staff to meet the needs and demands of changing research commitments.

With a very large staff you get into a problem of getting enough contracts to meet the payroll. If you have a very small staff you become very limited in the kinds of work you can take on. We thought the ideal arrangement might be to have a small versatile staff, particularly skilled in the methodology of policy research, and then a larger pool of people with diverse expertise that can be drawn upon fairly flexibly. We hope to draw upon the expertise of faculty members on all campuses of the University of California in this way.

Senator NELSON. You are planning to do contract research?

Miss ARCHIBALD. This is planned to be primarily a contract research corporation, the initial support, the "seed capital" comes from the University of California.

Senator NELSON. Does it remain an integral part of the university?

Miss ARCHIBALD. Well, the word we have been using to describe it is to say it is a semi-independent part of the university. Perhaps if I could leave that for the moment—I do get into it more specifically later, as to how it looks different from the standard university institute which is our standard research unit.

Senator NELSON. All right, if I don't understand then I will ask this question again.

Miss ARCHIBALD. Fine, I think that will be answered later.

4. Significance. It perhaps goes without a saying that one requirement of a policy research program is that it do significant work, that is, work that contributes something of importance to the policy issues of our day, or of tomorrow.

There is no way of guaranteeing significance but there are ways of encouraging it: by having first-rate research people; by maintaining good external relations, particularly with responsible decisionmakers; and by providing a setting that facilitates significant work. Two facets of such a setting are (*a*) to have the flexibility to move into new lines of inquiry when problems are anticipated but before they are

salient as policy issues, and, (*b*) to maintain several major interdisciplinary programs concerned with long-term policy issues or problem areas.

This is not meant to suggest that short-term projects are intrinsically of lesser significance, nor that a policy research program should avoid working on short-term projects. Both short- and long-term policy research is important, but long-term work takes on greater significance because it is more difficult to handle intellectually and to sustain financially and thus tends to lose out by default.

5. Interdisciplinary work. For most policy problems, interdisciplinary research is required and this commonly means a team approach. Although the interdisciplinary approach is often accepted in principle it is difficult to realize effectively in practice. Because it "does not come naturally," a policy research program has to pay some attention to the means of facilitating interdisciplinary work.

6. Access. The main purpose of policy research is to contribute to policy and this means having access to policymakers. A policy research program should have both formal and informal avenues of access: formal, through doing at least some cooperative research, that is, research on contracts; and informal, through individuals on the staff who are known and respected by policy officials. Time and effort must be expended on both internal standards and external relations to maintain effective and mutually beneficial working relationships with clients.

When we looked at the difficulties or ease in meeting these requirements within a university setting it very quickly became clear that standard academic organization and academic tradition poses problems for policy research.

It was not by accident that systems analysis developed within the nonprofit corporations rather than within the universities. The key problem is that the organization of universities is very largely determined by the traditional disciplines and the disciplinary boundaries can often be quite rigid.

Further, the incentive structure of the university primarily rewards those faculty who contribute, through publication in scholarly journals, to the advancement of basic knowledge in their own discipline. Not only does policy research tend to be interdisciplinary but also it tends to have a lower publication-to-effort ratio than pure or basic research.

Research within universities is typically conducted under the administrative aegis of a research institute or center. These organized research units do not reflect disciplinary boundaries in the way that departments do; nevertheless, they do not seem to provide the requisite conditions for the conduct of interdisciplinary research and analysis. The majority of university research institutes and centers put primary emphasis on individual research and scholarly publications. They often become the center for multidisciplinary discussions, but they are seldom the source of interdisciplinary teamwork. And research that combines the efforts of both the physical and social sciences is almost nonexistent in university settings.

This suggested to us that an organization designed for the conduct of policy research would have to deviate from the standard institute pattern.

If it is somewhat difficult to do this kind of work within a university setting then it might be asked: Why should policy research and analysis be connected with a university? What are the benefits to policy research and to the university from such a connection?

I think probably the most important thing is, as seems to be very clearly the case, there is this need for trained personnel and the logical place to train people is within the university. And it is difficult to train people unless you are actually doing this kind of work within the university.

The second thing is that major academic institutions—and particularly State universities supported by public funds—have a responsibility to contribute to more effective public policy.

A third thing that at least entered into our decisions in thinking about the policy research organization was that it seemed that a university setting might be able to minimize some of the problems that the nonprofit corporations experienced. If, from the point of view of policy research, the traditional university institute is tied too closely to the academic structure, then it could be said that, on the other hand, the nonprofit corporations have sometimes suffered from being tied too closely to governmental agencies. The nonprofits have had some problems in attaining and maintaining both independence and significance for this reason.

Government agencies are bound to exert some pressures on organizations that are doing research for them; these pressures will be greater if the research organization is wholly supported by one Government agency. Many of these pressures are quite legitimate; the agency needs some help on a problem and hopes to get that help from its research organization. Nevertheless, some of these pressures have to be resisted by a research organization if it is to maintain the quality and independence of its work. Certainly those pressures to come up with conclusions and recommendations supportive of the preexisting views or positions of the client agency fall within that category; so do some of the pressures to do short-term, rush projects to meet immediate needs.

While it is important for a policy research organization to work closely and cooperatively with Government agencies, one of the great values to a client of an outside research organization is its independence and its attention to long-term and fundamental problems. Client agencies confronted with crises from day to day often forget this, and a research organization too closely tied to a client may also be prone to forget it from time to time.

An additional liability that some of the nonprofit corporations have had is that of being relatively isolated from any larger intellectual community. It should be to the benefit of both policy research and basic research that they not become so insulated from each other that reciprocal influences cannot be exerted.

A fourth factor suggesting a university connection is that perhaps the best way of assuring the increased use and further development of systems analytic techniques and related approaches is to securely link this field to the institutions of higher education. Here, I think, it is not just a matter of training people but of increasing the acceptance and legitimacy of the field.

Now to the question you raised earlier about the structure. As I mentioned, it is a hybrid structure, in some ways it looks like a nonprofit corporation and in other ways like a university institute.

It looks like a nonprofit corporation in that it will have its own full-time research staff; in selecting research programs on the basis of their relevance and utility to the solution of current and future public problems; in doing interdisciplinary work involving the physical sciences, engineering, and the social sciences; in developing a research strategy that will pay attention to the rhythms and needs of government as well as to the rhythms of academia; and in being concerned about developing the in-house capabilities of client agencies it works with.

It will look more like a university institute in having a relatively small full-time research staff and in drawing flexibly on faculty resources, particularly the Irvine faculty, but also the other campuses of the University of California; in maintaining close contact with the academic departments; in contributing to formal educational and training programs; and in concentrating on fundamental problems and the development of the state of the art.

Does that answer your earlier question as to the structure?

Senator NELSON. Not that it is pertinent to these hearings, but, is it still an institution within the jurisdiction of the management of the university?

Miss ARCHIBALD. Very much so, yes.

We will pay some particular attention to problems at the State and local levels. California, with its size and growth rate, provides an ideal social laboratory. Also, our location in Orange County means that we are in the middle of a new and rapidly developing urban complex.

We are fortunate in California in having considerable interest in and experience with research and analysis in both the executive and legislative branches of the State government. The further development of this interest and expertise would seem to be important to all parties concerned.

One way of developing both the in-house capability of the policy-making agency and the policy sensitivity of the researchers and analysts is to work out a system whereby the analysts spend some time in government agencies and government personnel spend some time in the research organization. We hope to be able to work out such an exchange and we are currently exploring the potentialities here.

During your hearings in May, both Mr. Enthoven and Mr. Rowen mentioned that we do not yet have a clear idea how best to train people for systems analysis. Since Mr. Enthoven and Mr. Rowen are probably the two people in the country who have given most thought to such training and have had most experience with setting up programs, they have indeed pointed out a serious problem.

Public Policy Research Organization expects to start a training program on a modest scale within the next 2 years. We plan first to take a careful look at some of the training programs that are now in existence, and to learn from their experinece and, as well, to pay some attention to the training function that Rand, in fact, has performed so well for many years even though it has not been a formal training institution.

There seems to be, as of now, general agreement on two of the ingredients needed for training: (1) a strong and quantitatively oriented training, perhaps not solely in one discipline but in relevant aspects of several disciplines; (2) involvement in the actual conduct of systems analysis and related research.

A third possible ingredient would be some experience in working in a governmental agency. Even if these are the right ingredients, we still do not have a recipe that tells us how to mix them or in what amounts. When should a student start on such a program? At the beginning of his graduate career, in the midst of it, or perhaps at the postdoctoral level? How much time would be required? Can the time be shortened by use of such devices as case studies, possibly simulation, and other such techniques?

These are important questions since the successful use of systems analysis at the State and the local levels is dependent upon the availability of training both for people already within government and for younger people who will become those to be hired by State and local governments in future years.

I am pleased that the discussions on this bill are helping to shed some light on the problems in this area.

Senator NELSON. I take it one of the key functions of your institute will be to train systems analysts?

Miss ARCHIBALD. Right. We will start the research programs first; however, since that is our second function and it should be established before the training program. A little bit before, a year or so.

Senator NELSON. What have you projected as your objective in terms of numbers that you will train annually?

Miss ARCHIBALD. We have not projected that figure yet. I would think we would start relatively modestly. The University of California at Irvine is a new campus, we are only in our second year. I would think the growth rate in systems analysis would be rather similar to the general growth rate. I would think a beginning in this are would be about five or six students.

Senator NELSON. You will be training analysts in any and all disciplines in that area.

Miss ARCHIBALD. Right, and we also hope both to provide training for degree students who want to get—I don't know what the degree would be in—but who want to get a degree program, and also for people who have been out working in government agencies and want to come back for some training.

And another thing that has interested us as well: the interest in foreign countries in getting training in systems analysis is increasing and we would like to make our programs open for people from abroad as well as to American citizens.

Senator NELSON. Will your capacity to train analysts depend upon the number of contracts you have, or will you be running a separate academic program along with your contracting work?

Miss ARCHIBALD. Well, the academic program will be very much in conjunction with the academic departments, and the training function would not be supported out of contracts.

Senator NELSON. Will not?

Miss ARCHIBALD. Will not be supported out of contracts.

Although it will be important to have a strong ongoing research program before we get too much involved in training functions.

Senator NELSON. Do you have any views on what is the best way in which the Congress could draft a proposal that would help implement the utilization concept of systems engineering by local, State, and regional, and other governments around the country?

We have two bills before us, I do not think either one of them is the answer.

The one I drafted simply aims at following roughly the policy of 701 grants to be made by the Congress for planning purposes— regional, city planning, and so forth. I am sure there are better ways.

The other one establishes a national commission which would evaluate the problem.

The question is: What would be the best legislation, perhaps the best method to adopt when Congress is prepared to do so, to give grants and aid in the most effective fashion to induce the use of the systems engineering techniques at various levels of government?

Miss ARCHIBALD. I have only read the first of the bills you mentioned, the bill you drafted. It seems to me important, in terms of longrun purposes, to think about ways to get the most mileage out of the money, to use the first grants to prime the pump in order to get continuing programs and continuing interest at the State level.

In large part I would agree with Professor Geyer's comment that one of the key things will be to have a body of experts within the State or local government, monitoring work done outside the government and doing in-house work. This development of in-house capability at the State and local level seems very important.

I think I might disagree with Professor Geyer on his suggestion not to worry too much about institutional arrangements. This may come out of my discipline. I am a sociologist and I think institutions are important. It is not just a matter of individuals being interested; it is also a matter of institutional arrangements that channel, develop, and mobilize their interests.

I think the key one of those institutions is the one within the user agent—having in-house capability.

Related to that would be not trying to scatter the money too thinly among the 50 States, which I think you do not plan to do. It might be possible to have some criteria concerning longrun impact built into the process used to select grantees. Organizations submitting proposals could be asked to pay explicit attention to the way their project would have longrun impact on systems analysis. This would turn the worry about this question over to those organizations who are actually doing systems analysis. That might be a possibility.

Senator NELSON. Professor Geyer thought it would be feasible to provide some training in academic institutions in a brief period of time, maybe 3 months, for example, to budget analysts and administrators in various levels of governments—city, State, and local—to give them some good idea of the concept of systems engineering and some idea of what tools are available so that they would then be in a position to do something about implementing such a system even if they were not analysts themselves.

Miss ARCHIBALD. I think that is an excellent idea. The reason we had thought about making training programs available to professional people already working within public agencies was because this was one of the very great needs. Such a training program would have to meet their requirements and might have to be fairly short.

Senator NELSON. Do I remember correctly from your testimony that you would intend to invite exchanges between your own personnel to work in Government or private areas and vice versa for the exchange of orders?

Miss ARCHIBALD. Yes. This is not an ongoing program. We just are exploring it now, but this one we think has a great deal of advantage to it. This would certainly be tied into a training program as well.

Senator NELSON. I appreciate very much your coming here today and your very fine testimony.

Thank you.

Miss ARCHIBALD. Thank you very much, Senator.

Senator NELSON. Our next witness was to be Leonard Woodcock, vice president of the International Union of the United Auto Workers, and he is grounded in Detroit where they had some snow.

Mr. Frank Wallick is here from the United Auto Workers, on the legislative side.

Frank, would you like to present Mr. Woodcock's testimony?

STATEMENT OF FRANK WALLICK, WASHINGTON LEGISLATIVE REPRESENTATIVE, UNITED AUTOMOBILE, AEROSPACE, & AGRICULTURAL IMPLEMENT WORKERS OF AMERICA, AFL–CIO, ON BEHALF OF LEONARD WOODCOCK, VICE PRESIDENT, UNITED AUTOMOBILE, AEROSPACE, & AGRICULTURAL IMPLEMENT WORKERS OF AMERICA, AFL–CIO

Mr. WALLICK. Senator, I am sorry that systems engineering has not found a better way to get from Detroit to Washington in a snowstorm. Mr. Woodcock was anxious to be here and I have discussed the testimony with him a great deal and I know that he regrets that he cannot be here.

I am Frank Wallick, the Washington legislative representative of the United Automobile, Aerospace, & Agricultural Implement Workers of America, AFL–CIO, and I would like to present Mr. Woodcock's statement.

On behalf of our organization, let me say first we do support the objectives of the Scientific Manpower Utilization Act of 1967, S. 430. One of Mr. Woodcock's responsibilities as an officer of the UAW is to represent our membership in the aerospace industries, some of which have expressed interest in and support for this program.

We in the UAW believe that systems analysis, systems engineering, and systems management can give the American people new insights, new ideas, new directions, and new hope in grappling with many of the perplexing problems of our time.

At the risk of being trite, if our technology can hurtle a man through space around the world in 90 minutes, we can and must find better and easier ways to get to and from work, design and build cheaper and better homes to live in, rebuild our cities, clean up our air and water, reduce crime and rehabilitate criminals, and improve the quality of life for all Americans.

Senator NELSON. We might even be able to make microphone systems work.

Mr. WALLICK. Some critics of the systems approach argue that computers will not tell us anything new. To some extent this is correct. The real genius of the systems approach, as I see it, is a wedding of the many disciplines of the social and physical sciences.

By working together on a team basis, sociologists, mathematicians, and many other scientists can apply their special insights to finding new solutions to old problems that beset mankind.

The problems are urgent. We support S. 430 because problems of air and water pollution, transportation, education, and the decay of our major cities urgently need our attention.

It has been demonstrated again and again that the social costs of neglect far outweigh the investment required to deal with these problems.

We realize a very tight budget situation faces the Nation at this very moment. There is undoubtedly some reluctance by some industries to encourage Government spending for programs outlined in S. 430 because of the high priority of defense matters. This, if true, is a tragic mistake.

It is our deep conviction this Nation is strong enough to have both guns and butter. We believe investments made in education, the wars on poverty and pollution, and in the rebuilding of our cities are of immense importance and must not be postponed.

The kind of outlays we need for education, pollution control, and transportation are mere fractions of our ever growing gross national product.

Aerospace know-how is a great national resource. Aerospace technology is not the property alone of the various industries who manufacture space hardware. This magnificent technology which resulted from the impetus of the space program and from the demands for national defense, is the property of all the American people.

It is the American taxpayer who pays the research and development bill that makes our space spectaculars possible. This subcommittee is well aware of the vast amounts of tax money poured each year into research and development for space, defense, and other Government programs.

We strongly believe this brilliant engineering talent and organization should be used to improve the quality of the life for all Americans, not just for space and defense.

The space program may be tapering off. Last Sunday's New York Times, in a long, front-page story indicated plans for landing astronauts on the moon by 1970 "has plunged space planners into an urgent debate over where to aim next."

Mr. Chairman, it seems obvious to us that one of the targets for the space industry should be improvement of our environment here on earth by using many of the same facilities, technology, and manpower used for reaching the moon.

It is estimated that a man landing on Mars program would cost $100 billion and could be completed by the mid-1980's. A small fraction of this sum would go far toward improving our ground transportation systems and catching up with the housing and school needs of the people of the United States.

Labor has a stake in an expanding economy. Much of our enthusiasm for the systems approach in dealing with social problems

results from the plain fact that many of our members are employed by the space companies and these people face the grim prospects of unemployment unless new opportunities present themselves if the space program is reduced in size.

Employment, for instance, at the space division of North American Aviation, a UAW employer and a prime Apollo contractor, has dropped from 35,000 to 29,000 during the past year. If this downward trend should continue, our members face serious unemployment.

The UAW has always felt that employment opportunities, despite the hazards of automation, will grow with an expanding economy. In the words of the Automation Commission Report, "the basic fact is that technology eliminates jobs, not work."

Employment will certainly improve if aerospace technology is applied to social problems.

Systems teams should include people with horsesense. We have already said the genius of systems analysis is the happy combination of scientists working together from many specialties.

We also feel it can be demonstrated that persons with special knowledge, but perhaps limited education, can make a valuable contribution in developing essential information which goes into a systems analysis of a particular problem.

In the city of Detroit, for instance, the anti-poverty program used representatives of Detroit's poor in developing an information profile used to evaluate the Detroit program, using the techniques of planning-programing-budgeting system characteristic of the systems approach.

I am attaching a special memorandum describing this so the subcommittee can better understand it.

We feel systems analysis would be wise to include in early planning the special insights of people from the ranks of organized labor where this is practical.

Since S. 430 involves the systems approach in dealing with social problems, it is particularly important to get people with direct and immediate insight into the various problems.

Obviously, trained scientists must be relied on for the major technical work. But there may be many instances where poor people, working people, and people with ordinary, even humdrum experience can make a significant contribution to a systems team.

Experimental grants will stimulate industry. It is our conviction the aerospace industry will not get into work of social consequence unless it can be assured of some continuing interest by the Federal Government.

It is my hunch that if, let us say, Congress decided today to appropriate $1 billion to clean up the Mississippi River from Minnesota to the Gulf of Mexico, there would be a clatter of competition for that large amount of Federal money by many of our most sophisticated and advanced technological systems group.

The same thing thing would happen if Congress decided to launch a mass production low-cost housing program, using the systems approach.

One major aerospace industry demonstrated by systems analysis and systems engineering that aerospace technology could be used to vastly improve the construction of school classrooms.

However, the materials used in this construction were apparently more costly than commonly used materials. The maintenance of the new building was vastly superior to the old-fashioned schoolhouses so that once these schools were built they could outlast conventional buildings.

This aerospace company, however, was discouraged from embarking on this useful work and was unable to compete even though it made a vastly superior product.

If both procurement and maintenance costs were considered together on some experimental Government grant basis, aerospace technology might be harnessed to meeting some of America's school construction needs.

One possible flaw in this experiment is that the aerospace companies, to their credit, are accustomed to making a very high-quality product and are not used to lowering quality for the purposes of a mass market.

Certainly, it should be possible to make the equivalent of a Chevrolet on a mass scale in designing and producing low-cost housing or school classrooms, instead of designing for a Cadillac market.

The Northeast Corridor project is an example where systems analysis and system engineering has been encouraged by a substantial Federal subsidy to encourage better transportation for this densely populated part of the United States. We hope this program gets every encouragement from Congress.

We believe the proposals in S. 430 or special Government grants by existing agencies can harness the technological know-how of aerospace and comparable industries to make real progress in the problems that beset this country.

Finally, Mr. Chairman, let me emphasize the UAW's deep interest in S. 430 and may we urge you to press Congress for action this year.

This can be the beginning of an exciting chapter in the American story, where the new technology that sends a man to the moon can make life better for him here on earth.

I have not read this supplementary statement but I think it will be of value to have it for the record.

Senator NELSON. We will print the supplementary statement for the record.

(Statement follows:)

SUPPLEMENTARY STATEMENT: "MANAGING THE POVERTY PROGRAM IN DETROIT"

During the past eighteen months, Detroit's poverty program has experimented with adapting the electronic planning and budget control techniques, now so extensively used in industry and defense, to its human services program. The project is financed by an OEO grant, most of which has been subcontracted to Touche, Ross, Bailey and Smart, a local management consulting firm.

Crucial to the project's success was the development of a reliable method for quantifying client characteristics in a way that permits measurement of their progress from heavy reliance on public services to relative independence.

Anything as new, complex and frightening as an electronic device which acquires, analyzes, manipulates, and stores data about virtually every private aspect of thousands of people's lives is likely to be viewed by them with suspicion and hostility. To head off this predictable resistance, project staff worked closely with representatives of the poor at every stage of the system's creation. Staff explained the system's operation with charts and specially prepared texts. They also pointed out how useful and timesaving the system, if it proved to be workable, would be. Representatives of the poor not only approved use of OEO funds to finance the experiment, they also began attending regular meetings to help develop the all-important quantification scale.

Staff also drew on as many outside perceptions into the causes of poverty as possible, consulting with professional social workers, academicians, and several "people off the street."

Each "consultant" was given a chart similar to the one attached and asked to work across, line by line, rating the comparative importance of each characteristic for each type. When all results were in and synthesized, TRB&S worked out a numerical scale which theoretically measured each client's dependency. The scale ran from one to ten, with ten representing self-sufficiency.

Information about each client is collected at various intake points by regular interviewers. It is analyzed and coded by specially trained staff to insure consistency. Periodic re-measurements, and comparison with earlier ratings, should enable evaluators to determine how quickly each client is progressing, what his current needs and past successes are, what overall impact the poverty program is having, and how much it costs to dispense each unit of service. By shuffling data around, they can also determine which component programs are contributing most, and which least, to the city's fight against poverty.

Needless to say, this is all unproven theory. Similar systems work well in industry, but no one knows yet whether they can be successfully adapted to people's problems.

Staff is now testing what the machines say about clients against their personal judgment. If the rating scale works, then the entire system should. There will be errors in individual cases, but in a huge population such as the poor in Detroit, these errors should balance.

Using a computer, the system can recommend various strategies for dealing with the problems of poverty. It sets up mathematical models and, on the basis of present program performance, suggests the best mix for spending whatever money is available. It can also accept pre-conditions, such as the political need to invest heavily in highly visible services, and suggest how remaining funds should be handled. It can also predict how much time and money will be needed to finish the job.

Worksheet for preparation of quantified "dependency" scale

Types	Characteristics										
	Health	Education	Work experience and skills	Family stability	Urban adjustment skills	Total income	Income from public assistance	Alienation	Personal appearance, speech, behavior	Housing	Employment status: Fully employed, underemployed, etc.
Negro, male, 1 to 4											
Negro, female, 1 to 4											
White, male, 1 to 4											
White, female, 1 to 4											
Negro, male, 4 to 9											
Negro, female, 4 to 9											
White, male, 4 to 9											
White, female: 4 to 9											
9 to 13											
13 to 18											
18 to 25											
25 to 40											
40 to 65											
Over 65											

Senator NELSON. We are glad you were able to come over and present Mr. Woodcock's statement, we know he is one of the labor leaders of the movement in America and also a leader in other areas, including the area of education.

We regret very much that he was unable to be here.

We will leave the record open for 14 days for anyone who wishes to submit any additional material and it is possible that we will conduct 1 or 2 more days of hearing at a subsequent date in February.

With that, the subcommittee is adjourned.

(Whereupon, at 11:15 a.m., the subcommittee adjourned subject to the call of the Chair.)

SCIENTIFIC MANPOWER UTILIZATION, 1967

WEDNESDAY, MARCH 29, 1967

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON SCIENTIFIC MANPOWER
UTILIZATION OF THE COMMITTEE ON
LABOR AND PUBLIC WELFARE,
Washington, D.C.

The special subcommittee met at 9:40 a.m., pursuant to call, in room 4232, Senate Office Building, Senator Gaylord Nelson (chairman of the special subcommittee) presiding.

Present: Senator Nelson (presiding).

Senator NELSON. We will continue the hearings this morning on S. 430, the Scientific Manpower Utilization Act of 1967, and S. 467, a bill to create a National Commission on Public Management.

These hearings are being held before the Special Subcommittee on Scientific Manpower Utilization of the Labor and Public Welfare Committee.

Our first witness this morning is Mr. Arthur W. Barber, Deputy Assistant Secretary for International Security Affairs, Department of Defense.

Mr. Barber, we appreciate very much your taking time to come over here and testify this morning. You have a prepared statement, do you?

Mr. BARBER. Yes, I do, sir.

Senator NELSON. You may read it, or extemporize from it, or present it in any way you see fit.

STATEMENT OF ARTHUR W. BARBER, DEPUTY ASSISTANT SECRETARY (ARMS AND TRADE CONTROL), INTERNATIONAL SECURITY AFFAIRS, DEPARMENT OF DEFENSE

Mr. BARBER. Thank you, sir. I will read it.

Thank you for your kind invitation to testify on the application of the "system approach" to our pressing domestic problems. The views I will give will be on my own, and not necessarily a reflection of the views of the Department of Defense or any other organization.

As you requested in your invitation to testify, I will comment first on what is being done now in this field and, second, on the roles of and relationships between the Federal, State, and local governments, and private industry. Finally, I will close with some personal thoughts on the question, "What new institutions, if any, are needed?"

Perhaps it would be helpful for me to state my experience at the outset, in order that you can more properly evaluate my testimony. I am a physicist by training in the 1940's. I was a digital computer engineer and weapons planner for the Air Force in the 1950's. I am

currently working on disarmament and trade problems in the Department of Defense.

I have participated in discussions of the President's committee on the technological gap. I am also participating in the Independent Study Board to examine the effects of government procurement policies on regional economic development. This board has been formed pursuant to Public Law 89–136, the Public Works and Economic Development Act of 1965. I understand you played a large part in the enactment of this legislation.

In 1964–65, I served on the President's committee on the economic impact of defense and disarmament, with a particular assignment as chairman of the subcommittee on possibilities and policies for industrial conversion.

It was my opinion then, and it is now, that American management can readily adapt American corporations to suit the needs of this Nation. If most of our creative talents and intellectual resources are serving our fears rather than our hopes, the problems lie largely in the public sector—not with industry.

Let me turn directly now to your examination of the ways in which the Congress can assist in the spread of the "systems approach" to domestic problems.

The problems we face were stated by Vice President Humphrey recently when he said:

> The past few years, in our country, have been years of amazing technological and material progress and innovation. There has been a need for these things, and it has been met.
>
> But we also need social inventiveness, and social innovation and we need to create a market for them as well.
>
> We have urgent and keenly-felt public needs, most of them coming to a focus in the great urban areas where two-thirds of us already live and an even higher proportion will live in the future.
>
> But there has been no place, by and large, where people could go to shop for a better public school system * * *.

In short, our problems are money, markets, and management, in the public sector. With respect to the first of these, I believe that our society has the financial resources necessary to solve our domestic problems and to assure for all Americans a life of dignity and expanding opportunity.

Although public attention is most often focused on finances the problem is not primarily money. Despite expanded spending in the domestic sector, the application of the "systems approach" to domestic problems is making little or no progress. I think we should be quite clear about that.

The reason is simple and basic. No one is buying! While sales of textbooks, blackboards, and erasers, are climbing to alltime highs, no one has been shopping for a better school.

The difficulty is that there is a cultural gap between the managers of our corporate society and the managers of State and local governments. The gap is so large that it almost constitutes a language barrier.

The dynamic parts of American industry constantly reassess their goals and program objectives. They plan 5 years in advance. They analyze the total costs of programs, both in human and financial resources. They make rigorous analyses of private and public spending

over the next 5 years, and longer. They outline and analyze many alternative solutions.

While dealing with this kind of professional management capability, the State government executive, however competent, is relatively helpless. He is rarely able to plan 3 to 5 years in advance. He almost never has "thinking money" at his disposal. He cannot make budget tradeoffs, to increase the training effort, for example, in order to reduce welfare costs, or to increase capital spending to decrease operating costs.

He can abolish a job, or create new offices only with very great difficulty. He has little budgetary discretion. For example, school superintendents cannot make major changes in their curricula, and most can allocate only 5 percent of the budget available to them.

The government program manager cannot begin to achieve the effectiveness that is possible through government-industry cooperation until he is permitted a functional analysis of his job, establishing its goals and programs. When this is done there is no question that dramatic programs will begin to appear across this Nation.

I would turn now to the problem of the relationship between Federal, State and local governments. The fundamental problem is not research and development, or systems analysis, but management of the public sector at the State and local levels.

As the President said a few days ago to the conference of Governors:

> The Federal Government itself cannot teach a child, police a street, or rebuild a neighborhood.

When we look back at the awesome changes in our society in the past 20 years, it is amazing how little State and local government management has changed. Many governmental units have expanded their budgets 400 to 500 percent, and their personnel by similar amounts, without any reorganization or reexamination of the purposes or functions of government.

The result is that we are all the victims of the bureaucracy that emphasizes organizations and procedures and leaves the ends unexamined and unquestioned. We are not coming up with the right answers because we are not asking the right questions.

Most urban development deals with highways, crime rates, birth rates, income levels and disease rates, but rarely with the question of what is necessary to create a neighborhood in which a family can grow, prosper, and be happy. Alfred North Whitehead observed many years ago that:

> The greatest invention of the 19th century was the invention of the method of invention. We must concentrate on the method itself; that is the real novelty which has broken up the foundations of the old civilization.

Senator NELSON. Let me interrupt.

I notice you were directing remarks to State and local governments. All these remarks also apply to the Federal bureaucracy, do they not?

Mr. BARBER. Yes, sir. I agree.

Senator NELSON. I noticed you specifically named State and local government. My experience is that we are as bad off as the State and local governments are. Probably the Federal Government is worse off.

Mr. BARBER. Despite Whitehead's warning, we have yet to develop effective local political institutions to manage change. The result is that we react to change rather than reflect upon it and shape it to

our purpose. The future is not inevitable as long as we are willing to develop a set of goals and work toward them.

What can we do to encourage a society organized to meet human goals with all their complexity and variety, rather than the goals of the bureaucracy? First, we must recognize that no national program or series of programs can solve the problem. As Edmund Burke said many years ago:

> The nature of men is intricate; the objects of society are of the greatest possible complexity; and therefore no simple disposition or direction of power can be suitable either to man's nature or to the quality of his affairs.

Second, new programs—whether for schools or roads or the rebuilding of slums—should be determined and managed at the lowest possible levels in our society.

I cannot emphasize this point too strongly. I think it is the heart of our present dilemma.

I mean, for example, that the parents and children in a local school district should be intimately concerned with the planning and building of a new high school. Similarly, the people who live in slum areas can and should participate in the planning and rebuilding of the slums.

Third, I think there is nothing more important than to convince the people in our great cities and in the suburbs that they have a role in shaping their own future. How can we engage their interests in their own future?

There is one important way in which the Federal Government can help. I think we should seriously consider dramatic demonstration programs to set standards of excellence in education, urban renewal, and other major areas of concern in our society. The Federal Government might, for instance, establish an annual award for the best high school, junior high, and elementary school program in the country. The award might be a sum equal to 5 years' operating costs for the program.

It would be for the best school program—buildings, curricula, faculty, imaginative use of educational tools, community participation, and bus service—the program which most nearly fulfilled the needs, not of Washington, but of the local community.

Such a program would provide for the first time an opportunity to try to blend in a program proposal the multiple and complex talents that can contribute to American education. It would provide a politically responsible method for innovation in education. This would create an opportunity for an educational revolution which I feel certain would exceed our hopes and expectations.

The same type of demonstration program could be applied to the creation of an urban neighborhood, or a police precinct. Such an approach, in my view, meets many of the problems in bringing the systems approach to bear on new domestic solutions.

Finally, I would like to respond to your question concerning the needs for new organizations. Frankly, I think the primary problem is to introduce both flexibility and planning into existing public institutions.

The application of modern management techniques which have been effectively used by American corporations could and should be applied to State and local governments if we are to achieve the diverse human society which can be created within the decade. But efficient manage-

ment, while necessary, is not enough. There are values above and beyond cost effectiveness. What we badly need is a wider and broader public discussion and participation in the choosing of the alternatives open to American society.

It is here that I think there is a limited need either for new organizations or the adaptation of old organizations.

Specifically, I think there is a need for institutions free from both government and industry influence to bring to the attention of the public the issues and alternatives that lie before our society, in the decade ahead.

Let me give you an example of an unexamined alternative which has not been consciously addressed in our society.

I understand that it is now possible to orbit an equatorial satellite which would transmit 10 television channels directly to home receivers. Further, at the super-high-frequency bands where these satellites would operate, a total of 80 to 150 parallel television channels could be broadcast simultaneously to our homes. The cost of procurement and 5-year operating costs would be roughly $200 to $300 million for a program to bring 100 channels of television to every home in the Nation.

To be sure, there would have to be new home receivers and antennas, but I understand that the basic receiver would be available for less than $300 and a number of receivers could be fed by one antenna. Just think of a daily choice of 100 channels. Everyone would want his own television receiver to maintain family peace. Inasmuch as international television will be even more widely used, we might have a choice of skiing in the Tyrol, opera in Vienna, Kabuki theater from Japan, a Mexican fiesta, the Bolshoi Ballet, three or four news programs, 10 different sporting events, five to 10 soap operas, 20 educational programs, and 50 late movies.

We may never build such a system, but my point is we could if we wanted to. If the national community wants it, the demand must be expressed and translated into action.

Looking back with 20–20 vision, we can see that our failures have not occurred because of conscious decisions, but through omission. We never decided to permit pollution of our streams and air. We never decided to permit urban ghettos. We tended to ignore these problems until they no longer could be ignored. I consider it extremely important that some small nonprofit corporations and the universities bring to the attention of the public the alternatives that lie before us.

Thomas Jefferson once said:

> I know no safe depository of the ultimate powers of the society but the people themselves, and if we think them not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it away from them, but to inform their discretion.

I trust that your hearings and the bills under consideration by this committee will contribute to better public understanding of these issues.

Thank you.

Senator NELSON. Thank you very much, Mr. Barber.

I suppose the question before us is whether or not we can effectively use the techniques of the systems engineered to solve social problems.

Everybody recognizes the problems differ from applying the concept to defense systems or using it in NASA or for purposes of developing a system to make a moonshot, but the question is whether you can use the concept, the idea, as applied to the solution of social problems, and I take it that you agree that it can be——

Mr. BARBER. That is correct.

Senator NELSON (continuing). Even though there are some imponderables in this area that there are not in others. I would assume you could break it down at least into two general areas.

One question is, how do we do better what we already are doing, and the other question is, how do we evaluate whether what we are doing is what we ought to be doing.

There is not any question but what the first part is a lot simpler than the second part. We can, for example, institute a program planning budgeting system in a department or agency and evaluate the efficiency, the performance of that agency. We can do a cost accounting, so to speak, a personnel performance cost accounting.

Thus you can do a performance cost accounting to test the utilization of personnel or the utilization of space or the effectiveness of the performance of the job that is assigned to that department.

These problems, it seems to me, are relatively easy problems to subject to the concept of systems engineering.

There are lots of problems like that where you just take an operation and do an analysis of it to see how you can do better what you are already doing. However, it is one thing to do an evaluation to determine how effectively and efficiently the school is being run from the standpoint of space utilization and utilization of teachers' time, supervision of work and movement of kids from one class to another.

It is quite another thing to apply the systems engineering concept to the question of whether or not what you are trying to do in the school system is really very good, and what the alternative is.

The really tough question in education is how do you motivate the child?

If you have a really good school system, the children would be motivated on their own to do what we now try to push them to do. We have not done much of a job in the evaluation of that problem.

You mentioned something about pollution in your remarks. This is another question. I assume you would agree that there would be no problem—not that there would be no problem—but the concept of systems engineering could be applied to the whole question of atmospheric pollution, of air and water, that you could make an evaluation of what all the problem areas are, where all the pollutants are coming from, and alternative methods of disposing of or neutralizing the pollutants, and the cost factor. Systems engineering could be applied to that problem, could it not?

Mr. BARBER. Yes.

Senator NELSON. And the next question would be how you would solve it, and that moves you into the political area, which is quite another problem.

Have you read both bills?

Mr. BARBER. Yes.

Senator NELSON. I have not been satisfied with either one of them.

We drafted one in my office, and the Republicans subsequently drafted one on the House side. Do you have any suggestions as to how we might improve these bills in order to implement the idea of using systems engineering?

Mr. BARBER. Let me say I think both bills would be useful, but my general feeling is that to strengthen the bill on public commission, to permit it even two or three demonstration programs, would make it far more effective than it is now.

I think as it presently stands these bills would provide the means to educate the public, but the key factor as I observe it in our society is whether there is a market, whether there is somebody motivated to build something that serves the public interest and finds it profitable and useful.

I think our task here is to aline private interests with the public interest, and I think that it is possible to do so.

So if the bill on the public commission could be modified to permit a limited number of demonstration programs chosen by the commission, I think it would be a very powerful instrument, far more powerful than the limited amount of funds that would be required to do it.

Senator NELSON. In the bill that we drafted the Secretary of Labor was authorized to make grants to private and public institutions for demonstration purposes. Our draft did authorize the grants to private groups though we did not try to enumerate them or list them.

Mr. BARBER. I am afraid we are not communicating. I understand the grants were permitted for systems analyses on various studies, but what I am attempting to convey is that there is a distinction between public education, public reporting and programs of this kind, which I consider to be basically sound which educate the public, and a program in which there actually would be a two- or three-block area that would be dramatically changed, or one in which a school system was dramatically improved—in other words, something outside the intellect and the printed page, in the outside world, that was improved dramatically—a demonstration of excellence and hope.

Then people would begin, not only in the slums, but American corporations and investment houses would believe that this Government was going to take the steps necessary to create dramatic innovations in the public sector.

At the moment, in my contacts with industry, people believe first that it is technically possible, and second economically sound but, third, they don't believe anybody in the Government is going to be able to bring about the managerial changes that will bring about this kind of creative growth.

Senator NELSON. My guess is that in a proposed piece of legislation such as this one that a program that contemplated, say, a systems engineering analysis of some specific school problem or housing problem, and then also proposed to implement it with a good many millions of dollars to complete a demonstration program, would not pass the Congress at this stage in history. We are at the education stage, so to speak. If we could make some grants for studies to be done that might be acceptable to Congress. You might make grants to universities or groups of universities, for example, to train budget analysts and planners at the State and local level in the concept of systems engineering.

You would not end up making systems engineers out of them, but they would end up understanding what the concept was.

That is one area in the educational side that you might do. You might go further and do some funding of actual educational programs to develop within an institution a department for training systems engineers.

You might make a grant to a city of a million people to do a systems analysis of the transportation problem in the city, but I do not think at this stage in history the Congress would be prepared, once the analysis had been made, to appropriate the necessary millions of dollars to rebuild the whole transportation system. But the analysis of a city of a million, or half a million or 2 million, the analysis of the transportation problem would pretty well fit another city of comparable size. Thus all other comparble cities would benefit from the evaluations.

In other words, there are all kinds of social problems, and they are fairly comparable in cities of comparable size, so we might be able to pass legislation that would make appropriations to do studies on specific kinds of problems in specific areas.

These are at least the limitations of what I have been aiming at in this legislation. Any bill that proposed to do more and make a large appropriation to pay for solving the problem once you have analyzed it wouldn't pass the Congress.

If at some subsequent date we found out that we had some real solution to some very serious problems it may be that Congress might come up with substantial matching funds to meet it.

But what I am seeking to find out is the best approach to put some seed money into the area in order to develop some understanding of the concept of systems engineering and also to do some analysis of some problems around the country.

Who would make the decision as to what problems ought to be studied, and how would you approach it if you were drafting the bill?

Mr. BARBER. I am afraid I have not been too helpful, but I am quite concerned about this factor of expectations, and I think it is crucial because our society is a complex one, and it is the expectations of the people who are making these decisions that will affect their behavior.

Specifically, I am concerned about the following points: First, intellectually, the idea of systems engineering and programing and budgeting has become very fashionable in the past 12 to 18 months, and I think we must realize there is a very real danger in this fashionableness, because it can rapidly develop into an intellectual jargon which is a justification of the status quo.

I have seen evidence of this. People will take old programs and they will generate what they call systems analysis programs, and in reality not a thing has been changed, and they merely have painted them—their old, obsolete programs—with a new jargon and tried to persuade the outside world that they are modern.

You might say it takes one to know one, and I have been a government bureaucrat for years. A classic example, I can recall, and have seen this happen many times, was in the 1950's was the Propeller Laboratory at Wright Field. The Air Force changed its management many, many times, and changed its procedures of reporting, but the Propeller Laboratory went on for years and years and never

changed its programs, long after the Air Force was made up primarily of jet aircraft. I think there is a very real danger that with an expansion of intellectual concepts, that that would become nothing more than a sheen on the status quo, and I think this is frankly the estimate of what I consider to be the most informed people in the country in this area who are making the investment decisions and the allocation of talent in our society.

I don't know whether they are right. I hope they are wrong, but until we are somehow able to break through to the point where political institutions and popularly elected officials will create a new framework for the conduct of public programs, I think they are going to be right.

Senator NELSON. I do not think there is any question but what education of the public and education of the governmental institutions is a necessary precedent to appropriate utilization of this concept, but that all takes time.

I can recall very well back in 1959, 1960, 1961, when I was Governor of Wisconsin and I was advocating and did create several regional planning commissions whose objective was to do precisely this, that in southeastern Wisconsin there was almost no interest in regional planning commissions, and there was a great suspicion among the counties that they would lose some of their sovereignty and rights.

In a short time, after these commissions were created, they have become very popular, and they are doing a systems engineering job of evaluating problems in the area in which they are involved. They are doing a very good job.

I appeared before every county board in the area, and some of them two or three times, to try to persuade them to join in a planning commission. The same with the planning commission in central Wisconsin, but now there is political acceptance, and now they are making substantial headway.

The same with programing, planning, and budgeting, which we started before the Federal Government in Wisconsin. There was great resistance by the bureaucracy, who did not want that kind of thing. It is a long way from being perfected yet, but the concept is beginning to be understood, and I think that is the stage we are at here in attempting to find out what is the best way to utilize some modest amount of seed money in order to start an educational program so that there is some understanding of the concept, and in order to do some demonstration projects to show what the utilization of the concept can in fact do. What we are trying to do is to get a modest bill drafted that will accomplish some modest steps in the right direction.

Mr. BARBER. Let me, if I may, make a suggestion. Again going back to this question of expectation, because I agree completely with your view of the necessity for education prior to the voting of major funds: I think if the Congress of the United States indicated that perhaps 2 years from now it hoped to create a demonstration program, even that slight indication would be read very carefully by the people in this field, because there are already, as you are well aware, in the fields of medicine and education, tremendous corporate investments in which literally hundreds of millions of dollars are being allocated against research and development objectives and marketing objectives for markets that are 3 to 5 years in the future. I do not know whether this is legally possible.

It is not necessary that the money be available today. What is necessary is to convey to people the idea that within 3 to 5 years, which is the frame of thinking of most leaders in the private sector of our society, that the Government might try to make possible dramatic demonstration programs, the same way we have with SST's and other Federal programs.

Senator NELSON. I do not know that you would ever get Congress to say that something we do not understand now we will go full blast on 2 years from now, because I think the problem of understanding the concept exists in Congress as well as elsewhere in the country. So it seems to me that the point really is that if we could get some modest pilot projects going and some education programs going that it would develop on its own, because in my judgment, at least, the logic of the utilization of the concept is so compelling that it cannot be ignored.

It is not a new concept. The only thing new about systems analysis, I suppose, is that we now have machines that can help us analyze alternatives that you could not have done before without a massive number of mathematicians and planners.

So we have tools. The question is to train people in the utilization of the tools and educate people as to the efficacy of the concept.

I have thought that maybe some appropriation ought to be made available to the National Science Foundation to allow them to consult with private profit and nonprofit organizations, to allow them, in cooperation with private nonprofit and profit organizations, to evaluate how you ought to approach the problem and authorize them to make grants of various kinds as an experimental matter.

I appreciate your coming here. Your statements are very valuable and they are appreciated.

Our next witness is Emanuel T. Weiler, dean of the Krannert Graduate School of Industrial Management, Purdue University, and Daniel Alpert, dean of the Graduate School, University of Illinois, Urbana, Ill.

We are very pleased that you were willing to take the time to come here this morning and give us the benefit of your ideas on legislation.

I notice you both have prepared texts. You may present them by reading them or extemporizing, whichever way meets your purposes best. I would be happy to have either of you interrupt the other if you have an idea to add to the testimony.

STATEMENT OF E. T. WEILER, DEAN, KRANNERT GRADUATE SCHOOL OF INDUSTRIAL ADMINISTRATION, PURDUE UNIVERSITY; ACCOMPANIED BY DANIEL ALPERT, DEAN, THE GRADUATE COLLEGE, UNIVERSITY OF ILLINOIS

Mr. WEILER. I am E. T. Weiler, dean of the Krannert Graduate School of Industrial Administration at Purdue University. My colleague and associate in this statement is Dean Daniel Alpert of the University of Illinois Graduate College.

Dean Alpert is a physicist and has served in a major industry and the Manhattan Project before accepting academic appointment. Currently Dean Alpert is a trustee of the Institute for Defense Analyses.

I am an economist by discipline, a business consultant, and have served the Department of Commerce and the Federal Reserve Board.

We are here today as individuals to support the concept in the bills before you. We would like to see a national authority with the mission of reviewing proposed systems based programs and awarding, selectively, funds to the States, universities or other institutions, or organizations that could put them to use effectively in seeking out solutions to the pressing economic and social problems of our time.

The earlier witnesses before your subcommittee have made the case for the systems approach as a technique for problem analyses based on working experience in industry, government, and research organizations. The thrust of our comments today relates to the universities and how they might utilize systems techniques as they participate in the resolution of complicated, public problems.

As faculty members of land grant institutions, Dean Alpert and I have long been concerned about bringing the great competence of the universities into a more relevant relationship with the problems of the constituencies they serve. So has the leadership of the great universities in the Midwest been concerned.

The universities which are banded together for cooperative educational purposes in the Committee on Institutional Cooperation (CIC) appointed a committee several years ago to examine the relationship of the universities to the growth of the Midwest's economy. Dean Alpert served on that ad hoc committee on economic growth, which I was pleased to chair. The committee evolved into the council on economic growth, technology, and public policy of the CIC. I continued on as chairman of the council, and Dean Alpert serves as vice chairman.

Because it is the forum in which our universities have chosen to express and to articulate their concern, Dean Alpert and I shall draw upon the position of the council to document in part our views on the validity of the concepts in S. 430 and S. 467.

The council's basic paper proposed drawing upon the resources of the universities in multidisciplinary, problem-oriented research and action programs designed to contribute to the long-range productivity and social welfare of an urban and industrialized society.

The council has since adopted a position calling for a program of studies and systems analyses aimed at increasing understanding of the problems and potential which characterize midcontinent America. Such analyses would be oriented toward enhancing the means and capacity for aiding decision makers in devising action programs for regional growth.

While encompassing such social and economic issues as the control and availability of natural resources, the future character of transportation, and the nature of technological innovation in civilian industry, the analyses would also suggest alternatives for decisions that inevitably would involve human values and the political process. The systematic, broad gage study of regional problems is a natural extension of the many current investigations of social, economic and governmental issues being made on a local scale in the context of a single urban community or State.

Planning is underway for this experiment in which a consortium of universities would cause pertinent academic disciplines to interact on major socioeconomic problems through the common techniques of systems science. The task involves mastery of asking precise questions of the appropriate disciplines to obtain beneficial answers and feasible

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alternatives. It means coupling science—in the broad sense—with the social studies to develop viable policy end products.

Such a consortium would be a new departure. It not only would attempt to recruit working teams of problem solvers from the various disciplines, but it would gather the team members from two, three, or more great universities. It not only would try to order many knowns, unknowns, and variables in a small area, it would attempt to do that for a geographic region of several States. It would take the tenets of a technique demonstrated to be successful in the aerospace industry, revise them as necessary, and apply the resultant techniques to a complex net of social, economic, and governmental interrelationships.

We would be less than candid to suggest that the plans for a university-based systems attack on major social problems assure successful resolution. Certainly the problem are complex by virtue of existing interrelationships, in comparison to military and space requirements. Then too, the organization of academic personnel is challenging.

For as Henry Rowen of RAND—and some others—has told this subcommittee in recent hearings, the universities traditionally have operated within disciplines, and "problems just don't come cut that way." Mr. Rowen went on to point out that more difficult than identifying the problems that need solving is the matter of workable institutional relationships, particularly in the university community.

We submit, however, that the great midwestern universities have recognized this problem and are examining alternatives for the development of effective institutional arrangements.

In addition to the end products of a technical and policy nature, a university-based experiment could contribute to the training of an increased corps of systems analysts, engineers, and managers. These professionals would carry their skills into business, industry, government, the not-for-profit research organizations.

The universities—as Simon Ramo of TRW, Inc., told you earlier this year—should be producing individuals who have hybrid training as "politico-econo-socio technologists" and whose job it would be to work in the field of interdisciplinary science or interdisciplinary social arrangements.

As the universities have provided the society's professional people in the past, they are now called upon to provide the new breed of social engineers as indicated by the distinguished witnesses before this subcommittee.

May we point out that the midwestern universities with which we are associated produce a substantial portion of the advanced degree holders in the United States from departments of great academic strength. A recent study by the American council of education, an assessment of quality in graduate education, shows that these midwestern universities contained approximately 30 percent of the "distinguished" and "strong" academic departments in the 106 major universities studied.

May we call to the Senator's attention the relevant and supportive position taken by the National Commission on Technology, Automation and Economic Progress. The Commission, whose Chairman was

President Howard R. Bowen of the University of Iowa, proposed last year that the Federal Government "experiment with the formation of university institutes or interdisciplinary programs, adequately financed and fully integrated with the educational function of the university, which would serve as laboratories for urban problem analysis and resources for local communities that would want to use their advice and services."

One of the Commission members, Philip Sporn, in a separate comment, said he hoped "that recognition of the need and of their own responsibilities in our society will stimulate at least one or more universities and private foundations to undertake such a program on their own."

New regional institutions are developing, both intergovernmental and—in the Midwest—interuniversity. There is emerging a realization of the necessity for grasping problems regionally. To cite just two examples of that development in our part of the country:

The Upper Great Lakes Regional Commission has been formed under the regional economic development program in an effort to revitalize the economy of the northern tiers of counties in Minnesota, Wisconsin, and Michigan. The other is the Great Lakes Basin Commission recommended to the President by the Federal Water Resources Council under the Water Resources Planning Act of 1965. Both are examples of new institutional forms—cooperative enterprises involving groups of States and the Federal Government.

We believe that the university community can render substantial services to regional authorities by providing systems-developed plans and policies for their consideration and action.

A recent Brookings bulletin book review observed that some of the most difficult problems of intergovernmental fiscal relations arise where metropolitanwide action is stymied by organizational inadequacies or by the lack of "an objective basis for cooperative agreements among jurisdictions." The same might be said for jurisdictions within wider regions or areas. The review suggests that modern systems analysis can make contributions toward workable solutions of these problems.

Dean Alpert and I believe that legislation embodying the concepts in the two bills before you would provide some of the financial support needed to proceed in an orderly fashion with a systematic attack on major domestic problems. The method of operation proposed would allow the application of systems techniques by local and State governments, or by groups of States either through in-house capacities, or through the use of the talents of the private sector, the nonprofit research institutes, the universities or consortia of universities, provided the proposed projects had been duly evaluated by the national authority.

In 1965, before he joined the President's Cabinet, Dr. John Gardner said that it isn't anybody's business to think about the big questions that cut across specialties—the biggest questions facing our society. Dean Alpert and I believe that the universities are able and willing to address themselves to the "big questions." The kind of assistance envisaged by the legislation now before your committee would be of great help in the effort.

Dean Alpert is prepared to make some remarks, not of a prepared nature, which perhaps you would like.

Senator NELSON. Thank you very much.

STATEMENT OF DANIEL ALPERT, DEAN, GRADUATE SCHOOL, UNIVERSITY OF ILLINOIS, URBANA, ILL.

Mr. ALPERT. May I make some remarks, and I will use notes in this discussion.

Various witnesses at your committee hearings have set forth the validity and needs of the systems approach in the solution of many complex social, economic, and technological problems facing us as a nation, and the witnesses have also pointed out that the systems approach is not magic. It should not be oversold, or mismanaged.

I believe you have had some very impressive witnesses at these hearings, and that there may be little need for us to add specific examples of the use of this approach. I would prefer to address my attention to the possible mechanisms by which the Federal Government can optimize the uses of systems analysis and encourage its use broadly in local, State and regional areas.

How can you make it more likely that there will be a valid use of the systems technique?

The principal characteristics of a valid systems approach is that the problems are stated and approached with a minimum of arbitrary constraints. In reading the testimony before this committee, I was impressed with the fact that you have removed the constraint that the witness testify either for or against one version of the bill, or the legislation to support systems activity. In that sense, you have removed an important constraint, and your hearings have themselves constituted a systems approach to legislation.

I think it is interesting to comment that in this activity, you are the systems analyst. You have a problem, and it is a complex one, to formulate reasonable legislation; and you have a client for the study, your own committee and the U.S. Senate.

I think these three aspects are important components of systems analysis and management:

(1) The nature of the problem. (2) The nature of the client or sponsor of a study—a client who can act upon the study is one of the important ingredients, and this will determine whether a systems analysis is ever put to use—and (3) the systems engineering analysis team, which I sometimes call a systems-analysis team, and sometimes a systems-architect team.

The nature of the problem is rather obvious to all of us. Both the client and the systems-analysis team must view the problem as complex. If the client thinks he knows the answer beforehand and can state the problem unambiguously, you might as well stop right there. The likelihood that he needs or could use a valid systems analysis is not very great. In other words, the problem is often implicitly stated, rather than explicitly stated the first time. Usually, after you have looked at the problem for a while, the nature of the problem has changed, and it should be restated.

This says something both about the client-sponsor and the systems-analysis team. The client must be sophisticated and understand the

nature of the problem and the approach to the solution, at least at some stage of the game between the time the analysis is written and it is put into action.

May I hasten to add that not all studies have started out with a client at the beginning; and a classic example of this was the proposal to build an atomic bomb, which in a sense was done by systems analysts, a group of scientists turned engineers, who did not have a client. No one asked them to design a bomb; and they had to find a client by going, in that case, through Mr. Albert Einstein to the President of the United States, who designated a client.

The systems architect or systems analysis team must be good, it must be independent, it must be imaginative, and it must be practical. It has got to be tied in with the real world, and it is typically made up of a group of people from different specialties who have worked together as a team for some time. It is not necessary that the client and the systems analysis team report to different organizations. As a matter of fact, in modern industry you often have the systems analysis group and the systems management both reporting to the top management of the company. But if your long-range planning team is not independent of the operational part of the company, it is not too likely that valid analyses and counterplay between the systems planner and the client will take place.

In the public area, we have done it both ways. It is important that a client-sponsor, that is, a municipal government, have people who are sophisticated in the systems approach. In any case, whether they hire a study to be done on the outside or whether they carry it out within the organization—and you know, in the most successful areas of application, in the DOD and in NASA, both in-house and outside firms have been used in systems analysis—these characteristics, a knowledgeable client who can act on the basis of the systems analysis and an independent, well-knit analysis organization are necessary ingredients of a successful systems approach.

What happens if you have a good analysis team but you do not have a good client? Let us note parenthetically that, you can fail to have a client in many ways. If President Roosevelt had not listened to Mr. Einstein, there just would not have been a client—it would not have been possible for the group of scientists to engineer the Manhattan Project on their own. There are times when the client has prejudged the issue and wants someone to justify his decisions in technical terms, and you certainly do not expect to get very much out of that. And most likely in the present scene, particularly at the regional and local levels, if you had a good systems study it would be put on a shelf and collect dust in the absence of an able client.

For many of our problems, a client does not presently exist. As an example, take the situation where you have hundreds of separate school districts, each of which could use a valid systems analysis of its architectural problems, but none of them individually can afford either to pay for the anlaysis or, in some cases, to justify the capital investment that a joint client might afford.

And so in my use of the concept of client, and in my recommendation in this area, it seems to me that there are many situations in which municipalities are related in a larger megalopolis; but any one of them cannot individually carry through a study or act upon a study, let us

say, to improve the transportation or air pollution. What is needed is a new client, a joint client, perhaps, for many such districts, many such school districts or municipalities.

Sometimes the municipalities may not even be in the same State. It is very clear, it seems to me, that in fields such as crime prevention the characteristics of the problem faced by cities of a given size are very similar across the whole country. Technological advance as well as systems analysis might be done for dozens of cities jointly involved in a client relationship to such a study.

It therefore is my notion that legislation should be aimed in such a way as to grant funds to a systems analysis where a valid client is available, or to encourage, individual potential clients to collect in such a sense that if they had the study which they could otherwise not afford, they would act on it favorably.

In talking about the Commission which is proposed in S. 467, a commission for the study of systems analysis, it seems to me that this would be valid if the Commission itself were viewed as a client. In many of our national committees and commissions, we call together a group of very busy people who can meet, let us say, once a month for a year or 2 years, and what they are actually trying to do is to carry out a systems analysis of a pretty tricky problem.

It seems to me that above all, a commission that studies systems analysis should use the techniques of systems analysis that are available, and in the role of the client. It might well be that one could merge the thrust of these two bills by supplying sufficient funds to several commissions or to subcommissions, in different problem areas, which themselves would seek out valid client relationships and find sample areas where systems analyses could be done, always in the context that there existed a potential client or an actual client who could make use of the systems analysis.

Thank you.

Senator NELSON. Thank you very much for your contributions.

The Committee on Institutional Cooperation represents how many Midwest universities?

Mr. WEILER. Eleven midwestern universities, the Big 10, which you know, plus the University of Chicago.

Senator NELSON. What is that consortium prepared to do in terms of, say, running educational programs for city and State employees in order to teach them something about the concept of systems engineering, or is it prepared to do that at all?

Mr. WEILER. This is really a volunteer consortium of these universities, and decisions of this kind will be made by the Big 10 plus the University of Chicago presidents. It is conceivable that they could ask the consortium to do this kind of work, but the decision would not be made by our group. It would be made by the chief executive officers of these universities.

Senator NELSON. I did not mean what it was prepared to do. What is it equipped to do in terms of its own personnel?

In other words, does the consortium of universities have personnel, and would it be able to establish a program to provide 1 month, 6 weeks, or whatever, of training programs in concepts of systems engineering for city budget people and analysts at the State level, and so forth?

Mr. WEILER. The CIC can call on each of the 11 universities for staff, and there are precedents for having done this. There are a number of projects which are interuniversity in nature, and this is a means of pooling the academic resources of the 11 universities to accomplish an objective.

Now, each one has to be approached individually on an ad hoc basis. We are not set up to do this, but it can be done.

Senator NELSON. In the course of the hearings, I think the most common theme running through the testimony was that there is a shortage of trained systems analysts and the shortage of people who know how to use the systems concept. We raised the question in previous hearings of how you train a systems analyst, where are they being trained, what is a systems engineer or analyst, what courses are there in the country in the academic institutions and elsewhere where systems engineers are being trained?

The other aspect, the question of where you conduct some programs to train the people ought to be using that—that is, the State budget directors, city budget directors, heads of planning sections of your State government, or city governments, people who are not aware of the concept, or if so, vaguely aware, who ought to have a 1-month course or a 2-month course in what the concept is and how you would use it.

These two questions were raised several times and previous testimony indicated there ought to be more educational programs in the country to train analysts and there ought to be some kind of programs in the country to give some education to the people who ought to be using these analysts.

My query is, what expertise is there in the 11 midwestern universities and, too, is the personnel present to establish a program of giving 1-week training to heads of departments, 2 or 4 or 6 weeks' training to deputy assistants to heads of departments on systems engineering?

Mr. ALPERT. I would be less than candid if I were to say that each of our universities could just start in and give educational programs across the board to various kinds of units that need such education.

Typically, the characteristics of those people in our universities that are well equipped and sophisticated in systems analysis are those people who are truly problem oriented.

For example, in some of our engineering departments that tackle large scale, real problems in the real world, you find people that can educate and are educating a variety of people, including industrial people, in the use of systems analysis.

An example is our civil engineering department, which is providing a computer-based system. It is an educational system for small contractors throughout the State of Illinois, and teaches them the various aspects of systems approach, in the design of their building and the scheduling of their workers and so on.

Typically, one needs problem-oriented people, and problem-oriented areas in the university, and as many witnesses have testified, our typical professor is discipline oriented.

The manner in which we can cross disciplines and get an approach to real problems is one of the things we are addressing ourselves to collectively to see what is the best way of getting more problem-oriented people in the urban problem areas and in planning areas.

Senator NELSON. Are there, in any of the institutions, specific programs aimed at teaching people to become systems analysts?

Mr. WEILER. I do not know of any. They are usually the byproduct of other work, and as Dean Alpert has said, unfortunately for this purpose, universities are organized around disciplines, and the disciplines do not constitute the optimal kind of organization for producing these kinds of people.

Senator NELSON. But as to the second part of my question, if the 11 universities were requested to set up a program to train budget analysis in a 1-month or 6-weeks or 8-weeks program, would you have personnel within the universities to set up such a program and run it?

Mr. WEILER. That is a difficult question. I think we could find a limited number of people in the 11 universities who could do this. To be very candid, it would not be a very large number. This is an area that has not been well developed, even in these institutions, which are service oriented.

The land grant universities, the Midwest universities, have probably had more concern with service to their communities and their constituencies than most universities, but we have not learned to do this job for the urban society, and this is of course one of the advantages of the commission here. It would enable these universities to get geared up to do what I think they must do if they are going to fulfill their function.

Would you like to add to that?

Mr. ALPERT. Yes. It seems to me that support in the systems analysis area would best be done with a problem orientation rather than the technique orientation. I think that one of the characteristics of the Rand type of organization is not that they stressed so much the development of the technique, which was necessary, but it was a problem orientation that developed systems analysis. I think that would characterize a requirement. An interdisciplinary laboratory in a university, or an institution for public policy research would be one that tackled problems by bringing together teams of people to work on problems, and that is characteristically the way education gets done. People transmit to students and to others the kind of culture they have built up themselves.

Senator NELSON. I would agree with that. Would you apply that, however, to the case where you are simply trying to take somebody from one of the governmental bureaus and give them a brief introduction to what the concept is all about?

Mr. ALPERT. I think we could do that, and in our university it would be the institute for government, which now works with many of the smaller bureaucracies in the State of Illinois, to help in such ways. Again, it is a problem-oriented organization, and as the name implies, oriented toward governmental problems.

Senator NELSON. But you could take somebody, then, and give them a 6 months' course and introduce them to the concept of systems engineering.

Mr. ALPERT. We must be candid and say we would have to tool up for that. Our university would have to turn to this task, with the kind of interest and activity that they have turned to some of the other problems posed by the National Government.

In the case of space science, when NASA came along we did generate a number of groups in the university with a very great interest in the physics and in the science of space. I think that an orientation toward some of the problems which can be tackled in this area would represent the kind of challenge that would be needed to build up a greater capability in this area.

It should be cautioned that just to teach the techniques that are involved, when you take the systems approach and break it down into the separate techniques as such, they really require the problem in order to make them cohesive, and to make them meaningful in a short course.

Senator NELSON. I would agree with that. Most of the problems that budget analysts or a planner or somebody on management's side have been tackled some place in a systems form—and I suppose if you would run a program to teach them something about it you would take the area in which they are working where they have problems to show how those problems have been tackled elsewhere.

That is what I am trying to get at. Is there any place for you to train these people? This does not make systems analysts out of them, of course, but the problem is they do not even understand that such approaches to problems exist. As decisionmakers a necessary part of their education is to understand this approach to problems.

Mr. ALPERT. Of course, if the key decisionmakers in the governmental process just send down some of the people who have been in the bureaucracy 10 years or 20 years, to take a short course on the use of computers or the like, without having himself imposed some goals for his office, for example, that by such and such a date we will transfer into a program budgeting system—and we will do it either by getting some help from outside or by asking you to learn enough about it. I think one would then have the kind of incentive to really make a new system apply.

I think the decisionmaker, rather than the technician, is a key element in the process.

I admit, as I said, that you need sophistication at the technical level as well as within the decisionmaker's office.

Senator NELSON. I am assuming that the decisionmaker would have to be motivated to send the technician in the first place. I would assume further that it probably would be valuable to run a 1-week course for the budget director, for example.

Mr. ALPERT. Right.

Senator NELSON. Or whoever studies the problem of space utilization, and if he is motivated to come in the first place, at the end of the first week if the course is any good he is motivated to use the concept, and following that there is some understanding on his own part and he sends to the course whoever the technical people might be.

That is the kind of program, at least, that I have in mind, and I am trying to find out if there is any place in the United States where you could set up a program where you could give some education to the decisionmaker and subsequent to that to the technical people.

Mr. WEILER. Senator Nelson, I am sure this could be done within the universities. We were in part reacting to the kind of sophisticated client problem, the problem of getting the sophisticated client prob-

lem, the problem of getting the sophisticated client capable of dealing with some of the problems that now characterize the Midwest.

We will have a crescent city, starting from Madison and Milwaukee and swinging through Chicago across the northern tier of counties, across northern Indiana and including Michigan, including Cleveland and possibly Buffalo, within 20 years.

This is a whole new urban area here that just cries out for some kind of planned planning. We have masses of people who need to be moved into recreational areas both north and south. We have a transportation problem that is going to be a very, very difficult problem throughout this whole area. The kind of sophisticated client that is called for, in this case, to energize the kind of study that needs to be made in order to do this intelligently, in order to exploit the Midwest's real potential—it is the kind of client that takes more than a week or two to create, and this is what we really need somehow to do in the Midwest.

We also have emerging a new educational program. The space between these State universities is diminishing. With the development of television, we can have seminars in any university that are attended by people from all the other universities, and the whole problem of developing a regional educational program is a tremendous challenge, and this needs to be tackled.

We could go on. There are all kinds of problems that we are going to have to answer one way or the other within 15 and 20 years, which is a very short time.

Senator NELSON. In what you stated about the metropolitan complex in Madison, and across, Cleveland is one of the big problems, and needs some careful study.

Again, however, unless at the State level and the local level you can develop an interest and understanding of the concept, you cannot settle the big problem. You have got to start some place, and one of the places you have got to start is to educate at the local level and the State level, so that it will be understood that there are major regional problems that must be solved on a regional basis.

That is why I keep raising the question of getting some education programs started. We have got some people around the country who are prepared to analyze the biggest problems. We cannot find anybody prepared to analyze the little ones.

I think we have to build from the little ones to the big ones.

Mr. WEILER. You have a very, very fine point.

Senator NELSON. We will now take a 5-minute break.

I appreciate your taking time and your very valuable contribution. It will be helpful to us in working out legislation.

(Whereupon, a recess was taken.)

Senator NELSON. We will resume the hearings.

Our next witness is Mr. Robert Nelson, Director of Public Sector Projects, Raytheon Co., of Lexington, Mass.

Senator NELSON. Mr. Nelson, I appreciate very much your taking the time to come here and present your view today on these two pending bills.

Do you have a prepared statement?

Mr. NELSON. I do, yes, sir.

Senator NELSON. You may read it, or extemporize, or handle it in any way you see fit.

STATEMENT OF ROBERT NELSON, DIRECTOR, PUBLIC SECTOR PROJECTS, RAYTHEON CO., LEXINGTON, MASS.

Mr. NELSON. Thank you, sir. I appreciate being invited.

It is a subject of great personal interest. It is also a very broad subject, but today, I will just touch on two aspects in which I think both acts will be very helpful, and I hope you will find these comments pertinent.

I am Robert E. Nelson of the Raytheon Co., in Lexington, Mass., where I have been concerned with problems of the public sector and a private industry approach to them. The references I will make to Raytheon are factual but the opinions expressed are mine as an individual.

Raytheon is one of the aerospace companies that has contributed to the development of systems technology for defense and space programs. For some time now Raytheon has been involved in the transfer of these skills to the public sector and currently is conducting programs in educational systems, natural resource systems, transportation systems and, as a part of a major program for a foreign government, building communities including housing, schools, roads, sanitation, and water resources plus literacy and vocational training.

The applicability of the systems analysis and systems engineering tools to public problems has been demonstrated. The problems themselves are increasing in number and complexity. It is important simultaneously to increase the number of people in government at all levels, in universities and in industry who can administer and employ these techniques.

Further, it is important to provide a focus on these experiences so that the efficiency of these management techniques can be improved and their usefulness extended. The Scientific Manpower Utilization Act will contribute to the former and the National Commission on Public Management will provide the latter.

I would like to comment briefly on, one, a mechanism for providing immediate and effective training in the systems technology, two, an illustration of an impediment to solutions to public problems that could be overcome by using systems techniques under these acts, and, three, your specific questions.

Training. Qualified personnel are limited in number and continue to be employed primarily on problems of defense and space. Happily, there is enthusiasm on the part of a large percentage of these systems people for transferring their skills to public sector problems. Many are spending their own space moments increasing their familiarity with the social sciences and in analyzing related problems. The question of creating an effective transfer of these skilled people to public problems remains.

The universities have an important challenge to train both the new practitioners as well as the customers or end-users of the systems techniques. Several such programs are now being organized but it will take many years to produce the numbers of people needed.

We have, however, already been introduced to an effective mechanism for training on the job a large number of people in this field. Consider the California systems studies with which you are familiar.

Four studies were accomplished by four separate companies. But 50 companies competed for these study contracts.

What of the other 46? The fact is that each company assigned its best talent and developed its approach on the subjects of crime, information, transportation, or waste systems. Each prepared and submitted its proposal. Where a company lacked the requisite skills, it teamed with others and employed consultants. As a result, the knowledge of the subject and the analysis of the applicability of the systems technology to these problems now exists in a reservoir of 50 companies, not just four.

There is an additional advantage. Simultaneosnly, the State administrators had the opportunity to review and evaluate the best ideas of the 50 companies and in the process to increase their understanding of the problems and their understanding of the administration of these new techniques for their solution.

This kind of on-the-job training is meaningful and lasting. It is problem oriented. The experience gained is real. On a larger scale the movement of experienced people from an initial program at a State level to other State, regional, and local agencies can be expected similar to the progression of experienced people from Rand to the Department of Defense and now to other Federal agencies. As the capability expands so will the demand for its use. The Scientific Manpower Utilization Act could initiate and fund such programs.

IMPEDIMENTS TO THE SYSTEMS APPROACH

There are certain practical impediments to the use of systems analysis and systems engineering. Some are traditional and some are legal. Studies under these proposed acts could identify these impediments and suggest solutions.

For example, there is some evidence that technical innovation in building construction is limited by the existence of restrictive standards and codes. Certain community rehabilitation objectives might be achieved sooner at less cost if these innovations were available. But it may be necessary to demonstrate the value of these innovations in practice before the codes can be changed.

The answer might be found in a model project under a Department of Defense construction program which would have the additional purpose of examining objectives of the Department of Housing and Urban Development and precipitating innovations that would help simplify the urban rehabilitation problem. This is a complex system problem involving interagency cooperation and congressional appropriation. It might be accomplished under the proposed Commission.

RESPONSE TO SPECIFIC QUESTIONS

1. To the question of what is being done in the field, the answer is clearly a great deal. Without adding to the list you must have already, let me say that Raytheon is currently working on several additional uses of the systems approach for public problems and, if Raytheon is any reflection of industry at large, a great deal of planning for additional applications by industry are in process.

2. With respect to the role and relationships of Federal, State, regional and local government, universities, and industry, there is reason for some optimism.

The willingness of many Federal and State agencies to discuss systems approaches has increased dramatically in the last 2 years. Further, analyses required to support the program, planning, budget systems should accelerate this process.

Interagency and jurisdictional cooperation will be the key to success for many systems programs in the near future.

In addition they will depend on the development of sufficient skilled systems people, the selection of appropriate projects, and funding.

3. The proposed Commission, as a new institution, would be a wise move at this stage to provide a focus for the evaluation of prospective programs and to assemble data on actual experience. Other ad hoc institutions or authorities may be practical for large interdisciplinary projects in the future.

The public problems that concern us are complex and mounting. Every technological and management tool that will help bring these problems under control should be developed along with the organizations and personnel to use them. The Scientific Manpower Utilization Act and the National Commission on Public Management are important steps in this direction.

Senator NELSON. Thank you very much, Mr. Nelson.

You state that Raytheon is currently working on several uses of the systems approach for public problems.

Is this just in-house research, or do you have some clients for whom you are doing this?

Mr. NELSON. These are in-house research projects. In the fields of pollution, water resources, urban development, and additional applications of the educational systems concept.

Senator NELSON. Have you done, are you doing any work on a contract basis on any social problems in the field of using systems analysis with a client?

Mr. NELSON. On a contract basis, we are doing a considerable amount of work for several municipalities in educational systems, where we are relating curriculums development, the media required to meet the curriculums, and communications techniques, and there are several programs of that nature in process.

Just to run through others quickly: In transportation, we have a contract presently with the Federal Government in which we are teamed with a university, and working on the evaluation, the improvement, and subsequent design of a traffic control system to be employed in the city of Detroit. The contract is with the Highway Research Board.

In the major community building field, we have a contract with the Government, directly with the Government of Saudi Arabia. The basic contract is to provide a defense, military defensive system for the Government, but simultaneously, we are developing the communities.

Senator NELSON. What are you doing in the water resource planning?

Mr. NELSON. In water resource planning, we are particularly interested in the Merrimac River problem, up in New England, that

affects Massachusetts and New Hampshire, and the interests of both States, and the Federal agency in that problem.

Our work, as I say, has been in-house, to get up to speed for participating in such a program.

Senator NELSON. You aren't working on any contract basis?

Mr. NELSON. No contract basis in that instance.

Senator NELSON. What kind of work are you doing in resource planning? Is it just as respecting this watershed, or water resource use in general?

Mr. NELSON. With respect to resource planning, we have two subsidiaries who are pretty thoroughly involved in the analysis, land-use analysis problems, and in the exploration of mineral and oil resources. We are working with those subsidiaries to improve or to expand on their capabilities, to include some additional characteristics that we think a natural resources planning system should have so we are presently funded in several areas. They are the routine areas that those companies have been involved with in the past.

We are now building on them, for additional applications that we can see of value, particularly AID programs, for example.

Senator NELSON. If some legislation were to pass, such as the pending bills before this committee, do you have any ideas about what would be the best approach in funding, what kind of problems, what kind of programs?

In other words, if the Congress were to decide that it was worthwhile to make some appropriations for the purposes of education, for the purposes of acting with some specific social problems, regional or city or State, do you have any idea, any suggestions as to what might be the most useful approach?

Mr. NELSON. I haven't thought about them in terms of specific priorities, but the familiar ones of education, pollution control, transportation, are the ones that I think would be most meaningful to us, the ones that I think would be most meaningful to be started on in the near future, because there is a great deal that currently can be done in those areas.

There is much that can be done, without bringing in any particular new technology, working with the existing capabilities, but organizing them differently.

For example, in the pollution field, I feel that whether or not the Federal Government takes initiative, communities will find it necessary to band together to do things in their own best interests, because that way they can bring more effective financial capability and management capability to the problems, but I think the existence of these bills would greatly accelerate that process, and would certainly be beneficial.

Senator NELSON. Well, I want to thank you very much for your fine contribution, and for taking the time to come here this morning.

Mr. NELSON. Thank you.

Senator NELSON. Was your company one of the contractors in the California contract?

Mr. NELSON. No, it was not; nor a bidder.

Senator NELSON. Thank you.

That will conclude the hearings until tomorrow morning at 9:30 a.m.

(Whereupon, at 11:30 a.m. the subcommittee adjourned, to reconvene at 9:30 a.m., Thursday, March 30, 1967.)

SCIENTIFIC MANPOWER UTILIZATION, 1967

THURSDAY, MARCH 30, 1967

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON SCIENTIFIC MANPOWER
UTILIZATION OF THE COMMITTEE ON
LABOR AND PUBLIC WELFARE,
Washington, D.C.

The special subcommittee met at 9:45 a.m., pursuant to recess, in room 4232, Senate Office Building, Senator Gaylord Nelson (chairman of the special subcommittee) presiding.

Present: Senator Nelson (presiding) and Senator Javits.

Committee staff member present: Robert Patricelli, minority counsel to the special subcommittee.

Senator NELSON. We will open the hearings today on S. 430, the Scientific Manpower Utilization Act of 1967, and S. 467, a bill to create a National Commission on Public Management.

Our first witness is Michael Michaelis, manager of the Washington office of Arthur D. Little, Inc. We are pleased you took time to come this morning and give us the benefit of your views. Your statement will be printed in full in the record. You may present it any way you see fit, extemporaneously, or by reading it, or however you like.

STATEMENT OF MICHAEL MICHAELIS, MANAGER, WASHINGTON OFFICE, ARTHUR D. LITTLE, INC., WASHINGTON, D.C.

Mr. MICHAELIS. Thank you very much, Mr. Chairman.

I welcome this opportunity to join in your discussion of the "systems approach" to problems of public policy. Five years ago I had the privilege of serving as Executive Director of the White House Panel on Civilian Technology. I recall that we then recommended to the President that an Inter-Agency Task Force be created, and that it use the systems methods to guide Government actions in pursuit of social and technical innovation.

At that time, the issue that appeared to me to be the most crucial was how to increase the rate of utilization of new knowledge, so as better to satisfy functional needs of our society, such as transportation, housing and construction, education, and health care. That was 5 years ago; the issue today, it seems to me, is still the same. We are still searching for ways by which we can bring to bear the rapidly growing fruits of science and technology on the problems of everyday living.

I continue to believe—as I did 5 years ago—that the systems approach can provide a powerful stimulus to social and technical innovation. I also believe, and submit for your consideration, that a national council—representative of Government, industry, labor and

the professions—should be formed in order to experiment with new applications of these management techniques in all areas of social need. I will comment on such a national institution later in my testimony after first, if you permit me, considering the systems method in relation to its potential usefulness for guiding public policy.

In recent years, there has been increasing public discussion of this and related topics, to be sure—though much of the enthusiasm in support of new approaches had led to suggestions that are notably vague and exhortatory. It is all the more exciting and reassuring, therefore, that your committee is exploring how actually to utilize known and advanced management techniques—such as systems analysis—in the pursuit of national goals.

Note that I have said "known" techniques, for systems analysis as such is not new. What is new, once again, is the potential utilization of this technique, of this knowledge, to help solve age-old functional needs of society.

Several of my friends and former colleagues, who have spoken in these hearings, have already given you most adequate definitions and descriptions of systems analysis techniques, and of the "systems method" at large. For my part, I will merely attempt a summary of what seem to me the most pertinent characteristics and values of the systems method, before I go on to discuss the question of its potential utilization.

The systems approach encompasses three interrelated major phases: systems analysis, systems engineering, and systems management. The interaction between these phases is intimate and continuing: When a system is in operation, management and engineers continue to collaborate using the tool of systems analysis for operating decisions, much as they did in the design of the system in the first place.

The procedures of systems analysis vary widely, reflecting the inherent uncertainties of the problem under review, as well as the difference between organizations. However, the structure of systems analysis is quite consistent from case to case. It involves the following successive steps:

1. Understanding the objectives of the desired system in the context of its working environment.
2. Stating the interrelations between the objectives and the variables of the system that are chosen for analysis, thus constructing a model.
3. Quantifying functional relationships between elements of the model and its outputs, often described as the benefits.
4. Quantifying functional relationships between elements of the model and inputs or resources needed, often called the costs.
5. Combining (3) and (4) into an input-output or cost-benefit relationship that flows through the whole model.
6. Determining from the input-output relationships that choice of all possibilities of systems characteristics and manner of operation that produces the most desired result, and operating rates that correspond to that optimum.

Systems engineering starts when a selected system has been broadly specified, principally with regard to its desired performance. The essential job of systems engineering is to subdivide the broadly defined task of the system into more limited subtasks, thus permitting the actual engineering work undertaken in the development of a

system to be principally directed at well-defined problems, of limited scope. The great bulk of engineering in systems development is, therefore, not systems engineering, but the latter plays an essential part in insuring that the separate engineering subtasks can be integrated into a working overall system.

Systems management can be considered—in a somewhat oversimplified view—as an extension of the concept of decentralized management (practiced in many modern institutions) where such management is organized around a task with the scope of a system or subsystem. Thus, the traditional business functions of production, sales, finance, and R. & D.—whether performed in a centralized or decentralized manner in an organization—can be regrouped, for instance, to provide management and control of the system's optimum utilization of resources to achieve a given objective; that is, strategy; logistics support; staffing and training of personnel; procurement of special related equipment and supplies.

I will forbear from going any further into the technical complexities—semantic and otherwise—of the systems method. Suffice it to say that there already exists considerable evidence for its utility, particularly applicable to situations where a major change in a broad area of activity is needed.

Many of the techniques of the systems method are shared with other disciplines; its uniqueness is the scope of the problem to which it can be addressed. Its major value is the insight it provides into the interrelationship between parts of a whole—often leading to unexpected discoveries about objectives and values, or relationships, or facts. This opportunity for new discoveries is one of the most fascinating and valuable assets of the systems approach.

"Where do we go from here?" "How can we best use systems analysis to help meet major social needs?" These are the questions frequently asked today, and I believe they are the ones that most interest your committee. We have noted that the systems method can be applied to problems of great scope, and that it is particularly applicable to situations where a major change in a broad area of activity is needed. It is principally for these reasons that the systems method has been so successful in the development of our military defense capability and in our exploration of outer space. Both these efforts are vast in scope and require major changes in very broad areas of activity.

This is no less true of problems in everyday living, whether these be in transportation, or in education, or in health care, or in construction and housing, or the like. But there is a distinct and crucial difference between these civilian sectors of our economy and those of defense and space. That is to say, the problems of everyday living, reflected in the behavior of the market for goods and services of all kinds, have called into being an industrial complex of not only great magnitude but also great diversity. Here we are faced not with a centralized and integrated decisionmaking mechanism, as we are in the Defense Department, but with a multitude of customers and a multitude of competitive producers and service organizations.

This applies to all of the areas of social need that I have mentioned. In this situation, therefore, the systems method can have an additional and vital virtue. It can provide a common language between managers in government, in industry, and in labor, and the professional com-

munity in the research institutions, universities, and other centers of knowledge generation. This common language can provide a common understanding—about objectives, assumptions, values, benefits, and costs.

The question of "Where do we go from here, and how should we use the systems method?" must therefore be answered in the context of bringing together the multitude of decisionmakers to provide an optimized system for carrying out any one integral function of our society.

We must be most concerned with the ability of our decisionmakers to initiate and carry through innovations of great magnitude and impact. I said earlier that a major issue today, as it has been for years, is to find the way by which social and technical innovation can be brought about at a rate commensurate with the needs of society. This is not synonymous with merely saying that more scientific research and technical development are needed.

R. & D. is only a comparatively small part in the whole chain of innovation from the conception of an idea to the sale of a new product or service in the marketplace. R. & D. generally costs no more than 10 percent of the total cost of innovation; it occupies a comparably short timespan in the total chain of innovative events and, surprisingly enough, it often carries comparatively less financial risk than some of the other functions in the chain, such as marketing and distribution.

This is worth repeating: Innovation is not the same as R. & D. R. & D. creates new knowledge. Innovation is the process of utilizing such knowledge. Innovation thus entails the challenging of wisdoms and beliefs that are often long held and cherished by the body politic. Innovation, therefore, is a "political" process in which the systems method can provide assistance but can, by itself, provide no solutions. Personal values and attitudes enter significantly into the picture. Fears and ambitions joust with each other; labor and management seek compromises between apparently opposing viewpoints; the public and the private sectors attempt to do likewise—and each, whether an individual or an organization, proceeds from his own formulated set of objectives and assumptions.

In this situation, the systems method can provide a common language so that the battles that will be fought and the compromises that will be reached can derive from at least a common understanding. There are plenty of differences that will remain because we are, after all, human beings, and react differently even to the same stimuli.

There are, yet, few working examples of the usefulness of the systems method in a decentralized, fragmented, and traditionally adversary-prone situation. One good example has already been described to you in previous testimony. I refer to the school construction systems development project in California. You will recall that its most critical characteristics were:

(1) It focused on a functional need of society—educational facilities, in this instance.

(2) It expressed this need in performance specifications—thus opening the door to new concepts of meeting this need.

(3) It created a market—representative of real consumer needs and large enough to warrant serious attention by industry.

(4) It brought together those that had vested interests in this market, in such a manner as to stimulate fresh thoughts on old problems.

(5) It provided a collaborative mechanism, by which each participating institution could discover for and by itself what its enlightened self-interest had to offer—not only to itself but to the whole.

(6) It thus created new incentives for social and technical innovation and reduced existing barriers to change.

The last three points are, to me, the most interesting and vital. That is to say, this experiment in innovation brought together the vested interests who had traditionally controlled the human, financial, and technical resources that served this market. It brought together these vested interested in such a manner—that is, with a systems task to perform—as to stimulate a collaborative effort toward innovation and change. Each of the participating groups—government, industry, labor, and the professionals—discovered that its enlightened self-interest had a mutuality with that of the others. Each discovered that if he gave up a little of some of his most cherished practices—to which he had held strenuously for fear of being injured economically or professionally—then others in this emerging community of interest would be able to act differently from the way they had acted hitherto. These new actions could then provide opportunities which outweighed the possible injuries feared. As each participant, in turn, recognized this process of changing institutional relationships as of his own making, a favorable climate for innovation and change was created. That is to say, fresh incentives for social and technical innovation were found, and institutional, regulatory, and related barriers to change were reduced.

Senator NELSON. May I interrupt just a moment?

What was this construction systems development project in California?

Mr. MICHAELIS. In the testimony of my former colleague, Dr. Schon, there was a very full description. This was a project in California where the Ford Foundation had put some money for the development of modular building components for the purpose of building schools faster, more cheaply, and with better utility.

The name Ezra Ehrenkrantz as the leader of that project may have stuck in your mind.

Senator NELSON. I thought it had failed. Are they using the system now?

Mr. MICHAELIS. Yes, indeed. My information is that schools are being built in California to the design that was created and it has worked out more economically and in line with the desires stated initially.

Senator NELSON. I guess I will have to take another look at that. I thought they ran into problems at each level, building codes, architects——

Mr. MICHAELIS. I believe you may be thinking about something ifferent, because the extraordinary thing about this project was that it brought together the very groups you have just mentioned, who did then collaborate extraordinarily well.

Sentaor NELSON. I may have it confused. Go ahead.

Mr. MICHAELIS. This process of change in school construction did not center around the ubiquitous discussion of how much research and development might be needed and who should undertake it. At least, that question came up much later than usual, and it came in the proper setting of a positive environment for change that had already been created.

In that environment, the question of how much R. & D. and by whom solved itself. That is to say, the market demanded new knowledge; it exerted a pull to which entrepreneurs and scientists readily responded by committing their resources to the creation of needed new knowledge—because they were reasonably sure that barriers to the application of such new knowledge would not be allowed to persist and thereby make the new knowledge impotent.

In a real sense, therefore, the systems method was used to experiment with human attitudes and institutional obstacles to change. I use the word "experiment" advisedly. Studies were made, to be sure, but studies are not enough. These studies and the hypotheses derived from them were put through an experimental process of verification or modification, that is an experiment in which the vested interests worked together in a real time environment in order to test the possibilities for their own adaptation to new knowledge and new opportunities, and to test the consequences of their potential actions.

This experiment in school construction represents to me, in microcosm, what needs to be achieved on statewide, regional, national and, for that matter, international scales.

In previous testimony at these hearings, suggestions were advanced for a national committee or commission, set up to administer a substantial program of experimental and demonstration projects, using the systems method for the solution of public sector problems. This concept of a national commission or committee is a persuasive one and should, I suggest, be considered in the context of "bringing together the vested interests."

The studies, experiments, and demonstrations to be undertaken under the auspices of such a national body should be those, in particular, which have the effect of opening up public sector markets to the technological contributions of private industry (as in the example of the school construction systems development project in California.

A few years ago I served as chairman of a committee of the United States Chamber of Commerce concerned with industry-government cooperation in innovation. If you permit, I will refer to what I then proposed as a national council, which—if created—could well be responsive to the intents of the two bills before your committee.

Spectacular advances in American progress are possible. The Nation's total resources offer vast opportunities for advance and betterment. The institutional restraints between government, industry, and labor all too often, though, inhibit full collaboration between those who command complementary resources. The Council for American Progress is proposed as a new means to foster such collaboration and thereby to help our institutions and their decisionmakers adjust to the needs and opportunities of the future.

The Council for American Progress will exemplify the inherent unity of interest in our diverse society. It will seek and manifest consensus on the means of achieving national goals. It will illuminate

the opportunities for living up to our potential. It will identify actions we must take if we are to realize our expectations.

In order to achieve these ends, the council must be representative of both the private and the public sector of our society. It will need the fullest support and active participation from Government (executive, legislative, and judiciary), from industry and finance, from labor, and from the academic and professional community. It will be the purpose and responsibility of the council to confront these groups on critical issues pertaining to America's progress. Such confrontation and collaboration between these groups will be undertaken with the help of an interdisciplinary staff, skilled in the most advanced management methods, including those of systems analysis, systems engineering, and systems management. Such confrontation and collaboration—on a professional level—should lead to a better mutual understanding of the opportunities and obstacles before us, and thus to greater unity of purpose.

The council will not seek to supplant, impede, or circumvent any of our democratic processes and institutions. It will not make decisions, but it will help those who do. It will be a national focal point where all sectors and groups of our society will be called upon to reason together so that decisions made by them separately and elsewhere can lead to more purposeful and concentrated action for the common good.

The council will attempt to look into the future, and concern itself with the manifest and anticipated needs of society before these become pressing and critical issues of the day. It will thereby provide those who must make the decisions that shape our future with sound professional evaluations of the various alternatives for deploying the Nation's resources to meet its future needs.

It is recognized that other institutions exist—both public and private—which try to perform many of these functions. But each does so from the particular vantage point of its sectoral or professional base. The unique feature of the proposed Council for American Progress is its multisectoral representation: government, industry, labor, and the professions. The council will be independent of each and yet a part of them all. It will not operate under the prime aegis of any one of these groups, but it will forge links between them so that unity of interest can be transformed into unity of purpose.

The Nation's progress derives in large measure from technological, economic, and social changes—and from purposeful interrelationships between them. In most instances, the opportunities that new knowledge can offer are increasingly outstripping the ability of our institutions to exploit them. Major institutional and managerial innovations are needed if we are to fulfill our expectations and potentials. It is high time that we experimented with new institutional and managerial methods to utilize our great knowledge, just as we have experimented in the laboratories to create this knowledge.

Spectacular gains in scientific and technical knowledge stem increasingly from concerted interdisciplinary efforts of many specialists. We can expect similarly spectacular advances in the utilization of this knowledge from an interdisciplinary and intersectoral effort of the diverse interest groups represented in the council, working toward common objectives.

The Council for American Progress would set up ad hoc task forces to explore the potential for major innovations to meet more adequately the functional needs of our society: food, health, shelter, education, transportation, communication, energy, and so on. In many instances, these task forces will be established on a regional or State basis, in order to be most representative of local interests and desires. In every area of need and in every instance, the appointed task force—just as the council itself—will be composed of representatives from government industry, labor, and the professions.

It will be the purpose of each task force to identify the future needs of its region—or State, or for that matter the Nation as a whole—in its allotted field, and to evaluate all the resources now available and projected—human, technical, economic—that can be brought to bear. Many possible alternatives are likely to be found that could potentially meet anticipated needs. Modern analytical methods such as systems analysis will be used to evaluate the cost/benefit relationship of each alternative course and to compare them.

These methods of analysis and management techniques have helped us to build the strongest military defense system in the world. We can confidently expect to be able to adapt these methods to the development of every sector of our society. We can do so best, if government, industry, labor, and the professions deliberate together, with increasing unity of understanding and purpose, before decisions for action are made in diversity. It is the purpose of the Council for American Progress to aid in this unifying deliberative effort and thus to give each participating group a better understanding of its own opportunities for action in relation to those of all the others.

The task forces of the Council will be supported by an interdisciplinary, intersectoral staff (as will be the Council itself) skilled in formulating the problems and issues in which the task forces and the Council require objective professional judgments. These judgments will be sought from the best qualified groups and individuals in the country, under contract to the task forces and the Council. Many of these groups will be those alluded to earlier as representative of special sectoral or professional interests.

The deliberations of the task forces will lead to reports widely distributed by the Council, the importance of which will derive from the fact that a composite group prepared them, representative of all relevant sectoral interests—public and private. The influence that such recorded consensus of judgment can exert in unifying the diverse democratic policy and decisionmaking process, is one of the principal purposes of the Council. The other is the achieving of deeper understanding of consequences of their potential actions by those in the Council and its task forces who participate in the studies and experiments being undertaken. Since these men and women are drawn from high office in their respective organizations in the public or private sector, one can confidently expect that the mutual enlightenment through collaboration between them will lead each to make decisions for his organization in a manner both more imaginative and more complementary to those in related organizations.

It is essential, as I see it, Mr. Chairman, that such a Council for American Progress operate in an administratively neutral environment. It must not be the creation of any one of its participating

groups, and it must not operate under the prime aegis of any one of them. In its very creation, it must already observe one of the lessons that its future work is to impart to its participants; namely, that the mutuality of give and take between equals—at least in the conceptual stage of thinking through possible actions for the future—can create an environment in which those actions will be taken in the most productive manner. We must strive for a Council that is independent of each of its members but that is also a part of each.

If I may depart for a moment from my prepared statement, Mr. Chairman, I would like to interject some thought on the bill introduced by you, S. 430, and the one introduced by Senator Scott, S. 467.

I am in support of both bills, in the sense that I see them as complementary to each other. In bill S. 430, it is proposed to make grants to States "for the purpose of causing the systems analysis and systems engineering approaches to be applied to national and local problems." In bill S. 467, it is proposed that "a National Commission on Public Management be established to give attention to the development, dissemination and implementation of modern management technology and analysis of the systems interrelationships involved in public business problems."

From my proposal for a Council for American Progress, you will note that I believe that the salient features of both bills can and should be carried out simultaneously and in an integrated manner. That is to say, the purposes of bill S. 467 would best be served by actual, pragmatic experimentation involving all the vested interests in a particular public business problem.

That is one of the stated purposes of the Council for American progress. Another of its purposes is to conduct such experiments at the local level through local task forces; and thus it is responsive to the intent of bill S. 430.

In short, Mr. Chairman, I believe that the two bills are two sides of the same coin, and I suggest that the proposed Council for American Progress can mint this currency of our future wealth.

Mr. Chairman, members of the committee, in our explosively changing world it is no longer sufficient to live with shibboleths and concepts that served us in the past. We must take up a vital, flexible and ever-evolving concern about the nature and purpose of our society and about what constitutes a good life in light of tomorrow's needs and opportunities.

We must develop institutions that are geared to the chain-reacting growth of science and technology, and that are consonant with their impact on man's changing conception of himself and his world.

We must commit ourselves to dare to build the world we want, knowing that it is possible if we but demand it—and if we use intelligently all the potent forces of science, the arts and the humanities that are at our disposal.

Senator NELSON. Thank you very much, Mr. Michaelis.

On your proposal for a Council for American Progress, are you sort of proposing a national team of systems engineers with satellite teams of systems engineers evaluating regional, local, and national problems? Is that what you are talking about?

Mr. MICHAELIS. That is correct, but I would go further than systems engineers in the makeup of these teams.

In other words, I would primarily involve managers of industry, of government and of labor, with systems engineers as professional participants.

From the school construction systems project in California, for instance, one can derive some real insight into the psychology of change which grew in the minds of the managers who participated in that project. The need for the decisionmaker himself to become involved in the conceptual thinking through of consequences of potential actions is essential.

I do not think you can leave the task to the systems analyst alone.

Senator NELSON. I did not interpret your statement that way. You can perhaps give me a short statement that describes it better, and I will use it. All I am asking is, do you propose some kind of a national council, using the concepts of engineering and draw out every decisionmaker who might be involved in the picture to evaluate regional, State, and national problems. Is that it?

Mr. MICHAELIS. Right; yes.

Senator NELSON. How would you create it and how would you fund it?

Mr. MICHAELIS. I think you would probably have to start at the local level first, and let it grow to the national level over time. The initial funding, to get it started, one would hope—and this has not yet been explored in any detail—could be gotten from foundations.

It should then, I think, at a later stage, be funded jointly by the participants, on a matching basis between government, industry and labor. Those who participate should be those who fund it.

Senator NELSON. Who selects the Council at the national and local level, and who decides what problems they will evaluate? I mean who would in your proposal?

Mr. MICHAELIS. I think this again has to be a mutual wish of the potential participants to learn and to better understand the possibilities. In other words, it could be in any one area a politican, an elected official of government, or it could be a leading businessman or union official who takes the initial step to bring together leaders from the three power groups into a confrontation and an exploration of what areas of concern would indeed be the most profitable for their joint attack.

It would not necessarily be the same problem in all States. The educational field is one possibility, or it may be transportation, or it may be several such areas of community needs simultaneously, and you may need several task forces in any one area.

I think this has to be initially a self-generating mechanism. I sense, over some years now, that there is a great deal of groping between leaders in government and industry and labor for a collaborative mechanism. So that a coming together might not be a forced coming together, but rather a collaboration in the sense of "Let's see if we can work together in an environment that sets a perspective on what our separate tasks are and that gives us a chance of exploring the mutuality of our interests." Spontaneous combusion is a relevant concept.

Senator NELSON. I think the concept that you are talking about is a very interesting and useful idea. But I never saw a good idea spontaneously combust.

What is the generating force?

Mr. MICHAELIS. I believe that in different areas it would be different ones. It is more likely to be, I suspect, the State government and the Federal Government taking an initial step, inviting the private sector to join in a common task.

Hopefully, however, it would not put the stamp of either Federal or local government dominance on that task, but rather one saying, "We and you will try something together, and we will continue to support this."

So I would say the Government could well take the initiative in calling forth this kind of effort, and that it should give it continuing support, particularly important in the early stages to make sure that it has a fair chance of growing. But I do caution against it becoming a predominantly Federal or, in the States, a local government task, to which industry, labor, et cetera, may then only give partial attention from time to time.

I think it is very important that every one of these sectors feel that it is its own responsibility as much as everybody else's.

Senator NELSON. The reason that I drafted one of these bills in the first place, was to try to figure out a method, a feasible technique, for generating the interest in utilization of the concept of broad interdisciplinary planning, and that is the purpose of the bill.

The reason for drafting the bill was that it was my judgment that it was not going to originate on any local level because the patient does not know what is wrong with him. As a matter of fact, he does not even know in most cases that he is not feeling good.

He does not know what the problem is. I think it is very important, your idea of involving the decisionmaker. Without the decisionmaker involved, whether it is the mayor, or the budget director or the police chief, or the motor vehicle director, or the superintendent of schools, or whoever it may be, without having the interest and cooperation of the actual person who makes the decisions, it is not possible to implement a proposal no matter how good it is.

I like the idea of the Americal Council for Progress, and it reads very well. I just do not know how you will get it started.

That is the reason for introducing these bills, to find some technique for introducing some funding and exciting some interest in the concept both from the standpoint of educating people as to the need and demonstrating by some projects the results that can be accomplished.

I have not really figured out yet the best technique, and that is the reason for these hearings. I think it is a very fine idea theoretically, but it is not going to generate itself. You have to have some national leadership and regional leadership and State leadership, and you have to have some funding, because those who make the decisions on appropriating money are not going to make appropriations for something they do not understand.

Mr. MICHAELIS. I think we are on the same wavelength. What I have sketched out here, to be sure, is something that is not going to be created overnight. It will be a number of years in evolving, and your bill is certainly one of the first steps in creating interest and understanding in the methodology.

I am stressing that it would be good if such understanding were to be reached not in the abstract through studies, but on quite specific case examples, through actual experiments and demonstrations that

I am sure we can set up. It may be a transportation problem in your State.

Senator NELSON. As I am sure you are aware, there are some very fine examples of this already through the 701 grants that have been made to States and local governments for planning. I have not checked the legislative history, but whoever conceived the idea of making congressional planning grants was quite ingenious, and it worked very well.

Several regional groups in my State, and in other States, have utilized Federal funds which require the establishment of a regional planning commission, and they give them funds to make a comprehensive regional plan for the development of that region in terms of its resources, its institutions, its transportation, its population, its economics, its industry, and this does, in those areas where planning grants have been made, and where they have been successful, it has involved a broad participation by the city councils and members of the county board, newspapers, and all members of the community, and wherever that has happened it has worked very well.

So Congress has made grants successfully and is making them daily all over the United States to various regions and States for development of comprehensive plans.

Now, what we are trying to do here is to figure out a technique for doing several things, but one of them is to develop an understanding in the country of the whole concept of systems engineering and how it can be utilized to do whatever you are trying to do.

And, also, to get some demonstration projects going to demonstrate the efficacy of the concept. It is one thing just to give some grants and say, "You go ahead." That is what we have done, and it has had some very good results. We are trying to take the next step now, and give it some direction, some leadership on the national level, and that is what we are sort of fumbling around about here trying to figure out what the best technique is.

I am not satisfied with the bill I introduced, nor with the bill that the minority introduced. You mention that you endorse the concept of the national commission.

That proposal is in the minority's bill, and I endorsed the concept, too, but I do not know how it would work. I do not know who you would put on it or what they would do.

On the other hand, in my proposal we would simply grant funds to the Secretary of Labor and he would accumulate the expertise, or advisers, and make grants for experiments, and I am not satisfied with that, either. But if we were to draft a bill and had some seed money to accomplish what we are seeking to accomplish, or what you are talking about in terms of the American Council for Progress, how would you do it? If you had to draw up a bill for Congress, what would you do?

Mr. MICHAELIS. Well, I believe I would combine, even so, the features of the two bills, and I would try to determine a number of specific case examples for demonstration experiments. I would try and determine what representative examples could be set up in a number of States where the political environment for such collaborative efforts is promising, as it was in the school construction case in California.

I would look for similar situations in other functional areas, transportation and health care for instance, and I would set up relevant collaborative experiments in different States, involving the local decisionmakers with the help of professionals in the systems field. I would monitor this series of experiments from a national level through a national commission, or council, or whatever you wish to call it, composed not only of government people, but also people from industry, labor, and the professions.

I say, "monitor," because these national leaders may not commit themselves right at the start to becoming, say, the Council for American Progress, but they might one day grow into it as they themselves see the value of these methods at the local level.

In short, I say, first, that the systems concept, the methodology and its usefulness, can best be demonstrated by experiments in actual life, rather than by, let us say, hypothetical studies or scholarly articles only, which is what we have now.

Secondly, I say that a national commission, a group of men and women at the national level, can and should observe these experiments very closely to see what can be derived from them for larger national issues.

Experiment locally, observe nationally, and then maybe you will get to the point where you can act nationally, using the systems method to the fullest extent.

Let me say one last thing, Mr. Chairman. Let us try and not be driven too far into thinking that the systems method is simply a science and engineering process. It is that in part, to be sure, but that is not the critical aspect you are facing here. The critical aspect is not the generation of new methodological knowledge. The critical issue is whether the existing knowledge, or new knowledge you can create, will be used. And that use involves the decisionmakers directly.

Systems methodology should thus not be equated with "Let the scientist and engineer do it; he will find the solutions."

Senator NELSON. I agree with that. In drafting the bill, we had in mind the idea that you would do experimental projects both in terms of educating the decisionmakers as to what the concept is all about, and doing some actual, real-life projects involving everyone, including the decisionmaker, of course, and that an appropriation would be made to the Secretary of Labor, who then would accept petitions for projects, or originate them himself, whether they are in the field of transportation in some city or school administration or whatever it may be.

I am still not very happy with that approach, and I am not sure it would work too well.

On the other hand, the other bill, S. 467, proposes creating some kind of a national commission to study, and I do not know who would be on it, and who would do any work.

In other words, I am more concerned about the mechanics of the bill right now than anything else, because I do not think there is any doubt but that you set it up right mechanically you can creatively use the funds to tackle the problems you are talking about, because we have done it very well in a number of places in the country, and that is the part that I—you can set up a commission and have some mayors and Governors and Congressmen and everything else on it, so they

do nothing, and then they hire somebody, and it might be that they do not know what they are doing either.

I have thought of putting it in the National Science Foundation and authorizing them to hire their own consultants. They would have to do their own systems engineering on the problem we gave them, so to speak, and decide what are the limits of the experimentation we can do, what areas we can start it, and then proceed from there.

Mr. MICHAELIS. I have not thought this through. This is the first time I have heard this suggestion. I think the Science Foundation would undoubtedly be very capable of marshaling the scientific resources, the scientific understanding for the systems methodology, both in the physical sciences as well as in the social sciences, to be sure.

I would only wonder, off the cuff, whether it has the political power and ability of projecting this knowledge into experiments with the realities of everyday life. A home in the Science Foundation for an experiment of this kind might just possibly lead to excessive scientific attention and therefore, by the same token, to possibly an excessive disinterest on the part of the political and managerial establishment.

If I were to put myself in the position of the chief executive of a large company, on hearing that the National Science Foundation has charge, and I were asked to participate, I might just conceivably say, "I will send my research director. This will be scientists talking to scientists." We do not have to convince scientists that the method is useful, but we do have to convince managers, and that means that we must involve the managers. This explanation of new methodology must be a part of their daily responsibilities.

Senator NELSON. I am just looking for an established Federal institution that already exists to administer the funds. There would be no limit on whom they might consult. They would call in the American Management Institute, and they would call in the aerospace people who have worked in the field, they could call in the nonprofit organizations, they could call in expertise from all walks of like, and consult with them about how to approach setting up their own system analysis on the problem of meeting the situation, so to speak.

They might find some method or technique of administering the program. That is the problem. I am not really worried that we can make it work if we can find some technique to administer the program. You, or anybody else who has given it some thought, could name in 5 minutes more problems that ought to be evaluated and demonstration projects that ought to be done than we could do in the next 5 years.

For example, one of the biggest costs and one of the biggest problems in America is education. My own casual judgment about it is that among the biggest institutions in the United States are the institutions of higher learning, and among the worst-managed institutions in the United States are the institutions of higher learning.

If these large universities were a business institution they would have to fire every manager on the campus the next day. They just are not competently run from a management standpoint. The management of these institutions should be evaluated. We ought to have an appropriation and some kind of systems evaluation team working with the business managers, with the professors, and with the presidents

of several institutions just for the purpose of improvement, from the management standpoint.

I think you could do some revolutionary things in improving the management of the institutions of higher learning as well as the primary and secondary schools, most of which are run quite incompetently from a management standpoint, too.

But you need somebody, some team at the national level, who decides, who selects the problems that ought to be evaluated, and hires people to do it, to work it out. That is what I am trying to get at.

Mr. MICHAELIS. Yes.

Senator NELSON. Everybody who has testified, and the testimony is very good, agrees we ought to do something, but I have not gotten much good advice on how to implement it. That is the problem.

Mr. MICHAELIS. Is it reasonable to say that, since you mentioned education, obviously the Office of Education must be a moving force. If you think of transportation, the Department of Transportation or the Department of Housing and Urban Development must be such a force.

They themselves must be involved in the first place, because they have responsibility for allocating national resources and they themselves are managers of that process, and must involve themselves with the managers at the State and local levels, both in industry and government.

I am thinking out loud. Possibly a body that could act as a central coordinator, if you will, of separate experiments carried out with the help of these various agencies might be the General Accounting Office. I have not thought this through at all—the Comptroller General has a responsibility to assist Congress in providing control over the application of public funds. He has exercised this function traditionally on a retrospective basis, that is on how well we have spent public funds—after they were spent.

I suggest that he might also carry out a prospective function. It may be that the Comptroller General, assisting Congress, could coordinate the approach by executive agencies getting involved in various experiments in systems methodology. And such experiments might certainly involve the National Science Foundation, as a resource of physical and social science expertise. But I question whether the Science Foundation alone could accept the coordinating and initiative involved in what is in reality a political issue in the broadest sense.

Senator NELSON. That is a problem.

Thank you very much. It was valuable testimony. I appreciate your taking the time.

We will give the reporter a 3-minute break.

Our next witness will be Vincent Moore, assistant director of the Office of Planning Coordination, State of New York. The Honorable Timothy Costello could not be here.

We will have a 5-minute recess.

(Whereupon, a recess was taken.)

Senator NELSON. We will resume our hearings with Mr. Vincent Moore, assistant director, Office of Planning Coordination, State of New York.

Mr. Moore, we appreciate very much your taking time to come down here today to testify and give us your statement on these two bills.

Your prepared statement will be printed in full in the record. You may present it in any way you see fit, either extemporize from it or read it, whatever you wish.

Mr. MOORE. Thank you, Senator. I believe I will do a little of both.

Senator NELSON. Fine.

STATEMENT OF VINCENT J. MOORE, ASSISTANT DIRECTOR, OFFICE OF PLANNING COORDINATION, STATE OF NEW YORK, ALBANY, N.Y.

Mr. MOORE. Mr. Chairman, members of the subcommittee, I welcome this opportunity to participate in your hearings to investigate ways in which "systems approaches" can be most effectively brought to bear on our most pressing domestic problems. I also wish to express the regrets of the director of the office of planning coordination, Charles T. Lanigan, that previous commitments prevented his appearing before you personally, as he wished he could.

Your committee's concerns are, however, of considerable interest to the State of New York, and we appreciate your willingness to hear my substitute testimony.

It has been my privilege to serve New York State's dynamic administration for the past 5 years. My specific responsibilities have been the development of a systematic approach to the integrated planning, programing, and budgeting of the State government's operations. I should add that my service with the State has been with both the central planning and central budgeting staff agencies of the Governor, and that previous to this, I had spent several years as a planning consultant working with local governments of all forms.

The State of New York is now entering its third year of operational experience with formalized system for planning, programing and budgeting (PPBS). This system was initiated with Governor Rockefeller's approval in April 1965—5 months before the President instituted the Federal PPBS as a Government-wide system.

The work of the Rand Corp. and Defense Department systems analysts had little influence on the development of the New York State system. It evolved quite apart from these efforts—and I believe that our system with its uniquely different origins, demonstrates several important facts:

That there is sufficient universal recognition of the need for more systematic planning, programing and budgeting of Government operations to justify your committee's concerns;

That State governments, given progressive, sensitive leadership, can measure up to the tasks; and

That there are several different approaches to developing a more rational decisionmaking process in government.

I would like to briefly describe for you, the New York State approach to PPBS, and in the process provide you with our opinions and answers to your specific concerns of:

What is now being done in this field;

What the role and relationships should be in (*a*) the Federal Government, (*b*) State, local and regional governmental units,

(*c*) universities, and (*d*) private industry, both profit and nonprofit; and

What new institutions, if any, are needed.

We also have some comments with respect to the two specific bills under consideration here today, although these comments are not included in my prepared statement.

I have requested that copies of the New York State "Guidelines for Integrated Planning-Programing-Budgeting" be distributed for your convenience in following my explanation of our process, and respectfully request that this document be considered as part of my testimony.

Before describing the specific characteristics of the system, some comments regarding the origins of this effort are in order.

The initial momentum for the development of the document before you began with the establishment, by Governor Rockefeller, of the New York State Office for Regional Development in April 1961. That office (which was merged with another State agency in 1966 to form the present office of planning coordination) was assigned the task of preparing a comprehensive development policy for the State of New York.

In 1964 it produced its report, "Change/Challenge/Response" which has become somewhat of a famous, as well as scarce, piece of State planning literature. The report essentially sets forth a broad policy approach to the systematic planning and development of the State's physical, social, and economic resources. Lewis Mumford, the noted critic and urban scholar, has said of this report:

> Nothing of similar consequence to the art of planning the environment has been made since the establishment of the Tennessee Valley Authority.

The report contained 15 recommended actions, two of which form the specific basis of our current systems effort:

RECOMMENDATION NO. 4

> Formulation of comprehensive statements of statewide development factors and needs pertaining to urbanization, transportation, resource development, public facilities and other such fields. Such functional statements would be prepared by the concurrent efforts of interested State departments, private consultants, university faculties and other private or public agencies. The statements would be coordinated by the Division of the Budget and Office for Regional Development and would be subject to periodic review.

RECOMMENDATION NO. 6

> Annual preparation of and submission by the Budget Director to the Governor, as part of the proposed Executive Budget, of a specific physical program and a financial program for meeting such immediate and long-term State requirements are deemed feasible.

Translated into the technical jargon, these recommendations mean:

Systems analysis studies of the major functional action systems for providing the essential services and facilities required by the State's population; and,

A formalized integrated planning-programing-budgeting system.

These recommendations reflected the opinion of our State planners that the benefits of systems analysis approaches to functional planning

would be realized only if a formal system existed to create the crucial linkage of the planning and budgeting functions.

The State's division of the budget concurred in these recommendations as supporting the division's own efforts to refine our State's executive budget system in the direction of placing greater emphasis on considering and expressing the long-term impact of current budget decisions in a more programmatic format.

Accordingly, the State's director of the budget, T. Norman Hurd, established a budget planning and development staff as part of his executive office and by April 1965, that staff, working with the office for regional development staff, had designed and initiated the State PPBS in essentially the same form as the process I will now describe to you.

The State of New York has, as many of you know, a strong executive system. The majority of the department heads of the executive branch are appointed by, and report directly to the Governor. The Governor is responsible for the preparation annually, of a proposed executive budget. The State's fiscal year runs from April 1 to March 31.

Traditionally, the agency budget preparation for the following fiscal year began around June and culminated in September with the submission of the agency budget request. Formal hearings are held on the agency requests generally in October or early November and the Governor submits his budget to the legislature in January.

In New York State, as elsewhere, the growing magnitude and complexity of the State government's operations and the lack of a systematic approach to programing had the overall effect of reducing the time available for careful consideration of policy to the point where many decisions were being made on a crisis-by-crisis basis.

The PPBS system we installed in essence modified this traditional budget cycle by adding a 3-month period for long-range programing in advance of the initiation of the annual budget preparation by the agencies.

As the chart in the "Guidelines" indicates, our State departments and agencies now being their long-range program planning a little over a year in advance of the budget year related to the program plan. This program planning activity of the departments overlaps the beginning of the next immediate fiscal year which permits the agencies to take into account the legislative adjustments to their programs.

The long-range program planning culminates in our annual policy conferences in June. The major policy issues and administrative problems reported by the agencies are discussed and formally assigned for appropriate followup action during the summer months.

During the summer, staffs in the division of the budget and office of planning coordination review and evaluate the program plans and adjust and coordinate them on the basis of 10 major functional areas. An overall comprehensive report for the Governor's use in developing the subsequent executive budget is then prepared.

When the agency budget requests are received in September, they are accompanied by statements relating the requests to the long-range program plan.

A unique feature of our PPBS system is the uniform report format we established which both guides the departments and agencies in their

programing process, and facilitates the central staff review and coordination.

The State of New York is now entering its third year of operational experience with a formalized system for planning, programing and budgeting—PPBS. This system was initiated with Governor Rockefeller's approval in April, 1965, 5 months before the President instituted the Federal PPBS as a Government-wide system. I do not say that to suggest that we were first. I say that to indicate that the work of the Rand Corp. and the Defense Department's systems analysis had very little influence on the development of the New York State system.

Senator NELSON. I might add here that while I was Governor we started it in 1959.

Mr. MOORE. Pardon?

Senator NELSON. I wanted to say that we started the program while I was Governor in 1959.

Mr. MOORE. Yes, Senator. We have some people from your State working for us now, and they speak very highly of you, even though they work for Governor Rockefeller.

I think the evolution of our system from this somewhat different origin demonstrates several important facts.

First of all, there is sufficient universal recognition for the need of more systematic planning, programing, and budgeting of Government operations to justify your committee's concerns.

Second, I think that it indicates that State governments, given progressive, sensitive leadership, can measure up to the tasks.

Senator NELSON. May I interrupt? You are from the office of Planning coordination.

Mr. MOORE. Yes, Senator.

Senator NELSON. Would you describe that agency?

Mr. MOORE. The office of planning coordination is the State's central planning agency, with the responsibility for preparing an overall comprehensive planning process for the State. It is in the executive department of the State government. Our executive department contains the central staff agencies for the Governor, such as the division of the budget, the office of planning coordination, the division of State police, the division of military and naval affairs.

Senator NELSON. Does it include the personnel department?

Mr. MOORE. No; we have a separate civil service department. The State constitution limits us to 20 departments, one of which is the executive department, and the executive department has been used recently, really, to provide a cover for the new activities in the State government.

For example, we now have an office of atomic and space development, which is located in the executive department.

Senator NELSON. So you get around it that way.

Mr. MOORE. Yes. The office of planning and coordination is located at the same organizational level as the State's division of the budget. The director of the planning office, like the budget director, reports directly to the Governor, and with the budget director is one of the key policy advisers of the Governor.

The central executive policymaking team of the State of New York consists of the Governor, the Lieutenant Governor, the Governor's

counsel, his secretary, the director of the budget, and the director of the office of planning coordination.

Senator NELSON. How many personnel do you have?

Mr. MOORE. In our agency at the moment? We have approximately a hundred at the moment, and we plan to go to approximately 230 people over the next 2 years.

Senator NELSON. You could solve our unemployment problem. [Laughter.]

These are all planners?

Mr. MOORE. About 60 percent are professional planners, and we plan to triple that number.

Senator NELSON. What are the areas of functional planning that your agency does?

Mr. MOORE. We cover all physical, economic, and social development planning concerns. We coordinate the actual program planning done by the line agencies of the State government, first into functional plans for such activities as transportation, health, education, recreation and culture, economic development, natural resources development, et cetera, and then consolidate these functional plans into a comprehensive development plan for the State.

Senator NELSON. You have a department of conservation, do you not?

Mr. MOORE. Yes, sir.

Senator NELSON. Separately within your planning agency, do you do long-term resource planning for the State?

Mr. MOORE. We do some of it in our own agency, and parts of it are contracted out, so to speak, to the line agency.

Senator NELSON. Did New York not get a 701 grant for comprehensive State planning?

Mr. MOORE. Yes, sir; we are trying.

Senator NELSON. Did you get the grant?

Mr. MOORE. Well, we received $200,000 out of the current Federal fiscal year. Our total application calls for about $1.5 million of Federal money.

Senator NELSON. Is your comprehensive planning underway?

Mr. MOORE. Yes.

Senator NELSON. In what agency is that being handled?

Mr. MOORE. In our agency.

Senator NELSON. Then within your agency, that comprehensive State plan includes education, transportation, and so on. Do you do a long-range resource development program?

Mr. MOORE. It will be done partly by the office of planning coordination, which will develop the broad policy aspects of the resource plan, and advise the conservation department with respect to the activities of other agencies which touch upon the resource development plan.

The line agency then carries out its program operations within these.

I would like to spend a few minutes in describing our State PPBS system, because I think it will illustrate further, Senator, the points we were just discussing, and in the process I believe that it will indicate New York's answers to what is being done in the field of systems approach, and what are the possible roles and relationships of the Federal, State, and local, and regional governments, the roles of the

universities and private industry, and what new institutions, if any, are needed.

You have before you, Senator, a copy of the "Guidelines for Integrated Planning-Programing-Budgeting." This is the manual followed by each of our State agencies in conducting their program planning work.

Before getting into the specific characteristics, again I would just like to note the origins of this PPBS effort in New York State. The initial momentum for it began with the development of the State's office for regional development by Governor Rockefeller in 1961. That office, which did not have a statutory base, was merged with another State agency in 1966 to form the present office of planning coordination.

In 1964, however, the office for regional development had produced a report entitled "Change/Challenge/Response" and this report has become somewhat of a famous, as well as scarce, piece of State planning literature.

The report essentially sets forth a broad policy approach to the systematic planning and development of the State's physical, social, and economic resources. Lewis Mumford, one of our noted urban critics and scholars, has said of this report:

> Nothing of similar consequences to the art of planning the environment has been made since the establishment of the Tennessee Valley Authority.

The report contained 15 action recommendations, two of which form the basis of our current systems effort. The first called for the formulation of comprehensive statements of statewide development factors and needs pertaining to urbanization, transportation, resource development, public facilities, and other such fields.

Such functional statements would be prepared by the concurrent efforts of interested State departments, private consultants, university faculties, and other private or public agencies. The statements would be coordinated by the division of the budget and office for regional development and would be subject to periodic review.

The second recommendation called for annual preparation of, and submission by, the budget director to the Governor, as part of the proposed executive budget, of a specific physical program and a financial program for meeting such immediate and long-term State requirements as are deemed feasible.

These two recommendations, translated into the technical jargon, mean (1) systems analysis studies of the major functional action systems for providing the essential services and facilities required by the State's population, and (2) a formalized integrated planning-programing-budgeting system.

These recommendations reflected the opinion of our State planners that the benefits of systems analysis approaches to functional planning would be realized only if a formal system existed to create the crucial linkage of the planning and budgeting functions of the government.

The State's division of the budget concurred in these recommendations as supporting the division's own efforts to refine our State's executive budget system in the direction of placing greater emphasis on considering and expressing the long-term impact of current budget decisions in a more programatic format.

Accordingly, the State's director of the budget, T. Norman Hurd, established a budget planning and development staff as part of his executive office, and by April 1965, that staff, working with the office for regional development staff, had designed and initiated the State PPBS in essentially the same form as the process I will now describe to you.

The State of New York has, as many of you know, a strong executive system. The majority of the department heads of the executive branch are appointed by, and report directly to, the Governor. The Governor is responsible for the preparation, annually, of a proposed executive budget. The State's fiscal year runs from April 1 to March 31.

Traditionally, our agency budget preparation for the following fiscal year began around June and culminated in September with the submission of the agency budget request. Formal hearings are held on the agency requests generally in October or early November and the Governor submits his budget to the legislature in January.

In New York State, as elsewhere, the growing magnitude and complexity of the State government's operations and the lack of a systematic approach to programing had the overall effect of reducing the time available for careful consideration of policy to the point where many decisions were being made on a crisis-by-crisis basis.

The PPBS we installed, in essence, modified this traditional budget cycle by adding a 3-month period for long-range programing in advance as of the initiation of the annual budget preparation by the agencies.

As the chart in the "Guidelines" indicates, our State departments and agencies now begin their long-range program planning a little over a year in advance of the budget year related to the program plan.

This program planning activity of the departments overlaps the beginning of the next immediate fiscal year which permits the agencies to take into account the legislative adjustments to their current programs.

The long-range programs planning culminates in our annual policy conferences in June. The major policy issues and administrative problems reported by the agencies are discussed and formally assigned for appropriate followup action during the summer months.

Also during that time, staffs in the division of the budget and office of planning coordination review and evaluate the program plans and adjust and coordinate them on the basis of 10 major functional areas. An overall comprehensive report for the Governor's use in developing the subsequent executive budget is then prepared.

When the agency budget requests are received in September, they are accompanied by statements relating the requests to the long-range program plan.

A unique feature of our PPBS is the uniform report format we established which both guides the departments and agencies in their programing process, and facilitates the central staff review and coordination.

It is this format which is stimulating our applications of systems approaches to functional planning, and placing greater emphasis on the need for more improved communication between the Federal, State, and local governments.

You will note from the diagram that the program projections are reported in separate volumes for each major program area of a department. The format requires, in sequence:

I. The identification of exogenous factors influencing major program areas. These are factors such as changes in the population structure, potential scientific breakthroughs or technological improvements, changes in behavioral patterns, and changes in economic structure.

II. The projection of indicators of future levels of need for program services—at this point without respect to the responsibilities of the various government sectors or private sectors for meeting these needs.

III. The analysis and evaluation of the relative roles and responsibilities of the State government and the other levels of government and private enterprise for meeting the needs.

IV. The analysis and evaluation of the relative roles and responsibilities of various departments of the State government if the major program activities are split between two or more agencies.

The above four topics establish the policy base upon which specific program plans developed.

V. The establishment of specific program goals and plans, including the appropriate multiyear projections of program achievement and workload.

The final four topics, also on a multiyear format, present the projected requirements for the resources need to carry out the program plans.

VI. The projection of the personnel required to operate each program.

VII. The projection of any capital facilities required.

VIII. The projection of the overall fiscal support required.

IX. The projection of the basic research support required to improve the program operation.

As you can see, this approach, like most other PPBS efforts, establishes completely new manpower requirements, demands a much higher level of interdisciplinary and intergovernmental coordination and communication, and requires the development of complex new analytical techniques, and these are not achieved overnight.

We have had sufficient experience, however, to permit some comment on what we believe are some major problems requiring priority attention and can suggest some possible solutions which we feel will be of interest to your committee.

A. MANPOWER

Our State PPBS, because of its dominant emphasis on the need to link the broad comprehensive and functional policy planning process with the budgetary decisionmaking process, has touched off a major hunt for people who are capable of high level policy planning, evaluation, and coordination. Our central planning and budgeting staff agencies are constantly being raided by our own line agencies—and our present staff level is so critical that we will begin, next week, to mount what will undoubtedly be one of the largest, nationwide re-

cruiting drives for high level professional planners and public administration experts.

In the first instance, it is these people we need, rather than the technical systems analysts and model builders. We need well-educated, inquisitive, creative planners and public administration specialists who are people-oriented rather than machine-oriented. The wider their range of interest, the better. They need to have a deep understanding of our democratic federal system of government, and an intense desire to make our Government institutions true reflections of society acting in the collective interests of man. They need to be sensitive to human problems. They must read well, they must speak well. They must be able to negotiate and influence others.

Systems approaches to the Government's domestic problems must be organized and guided by such talented planners and public administrators. However, they should also have some basic understanding of the immense capabilities of the computer, and of the statistical and other simulation techniques of the systems engineer and operations research analyst.

It is rare that one finds such a person coming straight out of college or graduate school. While the planning and public administration schools are, on the whole, producing much better basic material these days, the fact of the matter is that leadership in system approaches calls for some practical seasoning in the day-to-day experience of the bureaucracy.

We should seek ways to better utilize the talent which is already present in our Government institutions.

I recently completed a feasibility study on midcareer education for comprehensive planning. The report will be published shortly by a group of consultants working with private foundation support on detailing a suggested plan for implementing the President's proposal for a National Urban Design Institute.

My recommendations call for an early identification, after some post entry experience, of potential leaders in comprehensive planning and public administration, and offering such people the opportunity to participate in an intensive 2-year work-study program which would be designed to both broaden their field of knowledge beyond their basic specialty, and to update and train them in the most modern techniques of planning and public administration. The "students" of such an institute would spend part of their time working on actual problems for actual governments or other agencies contracting with the Institute for such services. They would be paid a salary commensurate with their potential earning power as a full-time employee of the Government or corporation from which they were selected.

It appears that such a program could be financed almost completely by both contributions from the "student's" sponsoring Government (contingent upon his agreement to return to that Government for a specified time following his completion of the program) and from the proceeds of the Institute's contractural agreements with governments and other agencies desiring its services. Some small additional foundation or Federal grant assistance would probably be required.

Second, we need the technical manpower support for applying computer technology to planning and decisionmaking. I'm not speaking of people who know how to operate the hardware or do the actual

programing, but of professionals from the various disciplines such as economics, sociology, geography, education, penology, and so forth, who have had additional education in systems techniques.

I believe this training should be at the graduate level. In New York, the State government contributes to the cost of such continuing education required by its employees on a simple plan that takes into account the relation of the course to the employee's work activities and the grade he receives in the course.

B. IMPROVEMENT OF THE INFORMATION BASE

A second major priority is the improvement of the basic information base for planning. Our PPBS efforts have at least demonstrated how weak our information base is. Before we can deal with the data needs required by refined systems approaches and cost-benefit studies, we need to establish regional basic planning data banks which can continually update our inventories of population composition and distribution, economic structure, land use, housing conditions and the like. Systems approaches to ad hoc functional areas are not likely to contribute to the solution of our domestic problems if each application draws from separate sources for the basic central data required by each of them.

In New York, Governor Rockefeller recently proposed the establishment of such a central planning data bank to be utilized for systems analysis approaches to planning by the State and its local government units. We visualize that this central bank will ultimately be linked to our State's regional areas by a telecommunications system which will permit the localities of the State to also plan on the same information base with the State.

It seems to us that the Federal Government should establish a similar, coordinated network of data banks which could be tied in with such State systems.

C. INTENSIFIED RESEARCH INTO URBAN AND OTHER DOMESTIC PROBLEMS

Our third problem is the need for more intensive efforts in research into our domestic problem areas—particularly into urban problems. Millions of dollars are being poured into the preparation of local and State development plans. These plans, if they are to be truly effective instruments to guide decisionmaking, need to have a more adequate research base—and the research, like the plan, must be a continuing process.

It is extremely difficult to achieve an optimum level of sustained research activity at the State and local government levels. The fiscal resources of the States and local governments are far too scarce to be allocated to research at the needed level. Operating programs providing direct services must be funded first.

Yet proper research investment can ultimately lead to savings through more efficient program operations.

The Federal Government could do two things:

Insure that the tremendous research activity of the Federal departments and agencies under the stimulation of the Federal PPBS is regularly coordinated and communicated to the central

planning and budgeting staffs of the States and local government.

Provide greater recognition and more fiscal support for research activities related to the preparation of the State plans required by various Federal grant programs.

I would like to make two additional comments in conclusion.

Systems analysis as I have noted before is a contemporary tag for an element of the comprehensive and functional planning process. The Nation's planning schools were training "systems analysts" before the commercial electronic computer existed. Science and computer technology are undoubtedly providing the professional planner with far more powerful tools than ever before.

It would be an unfortunate mistake for democracy if we allow our fascination in these new powerful tools of science to obscure the greater need for people-oriented professional planners and Government institutions to conduct the comprehensive policy planning so desperately needed.

From my own surveys of the PPBS activity at other State and local government levels, I would say that there is definitely some danger of this at the present time. In many areas, professional planners have been shut out of participation in this process primarily because of the emphasis on program budgeting and the location of this activity nationally in the Bureau of the Budget.

Most State and local budget agencies are a far cry from the orientation and depth of professional talent and expertise of the Federal Bureau of the Budget.

The increasingly developmental role of the American government institution has brought a new climate of public opinion concerning planning. State governments are moving rapidly, local government planning is almost universal in our urbanized areas.

Yet we are still without a comprehensive planning agency at the national level to establish firm national development goals and policies.

The States cannot effectively coordinate Federal program activities even within their own jurisdictions.

The Federal Department of Housing and Urban Development cannot, in my opinion, coordinate Federal program activities effectively. Coordination supposes the existence of explicit development goals and policies as a basis for coordination. Department of Housing and Urban Development lacks the authority to establish and continually update national development goals and policies, nor does it have effective disciplinary powers over other Federal agencies.

The Bureau of the Budget has such disciplinary powers, but its basic concerns and responsibilities for financial planning and Federal budget execution do not, in my opinion, provide it with sufficient scope in terms of long-range national development planning which would seek to guide and coordinate State and local government planning in the overall national interest.

Indeed, the Federal PPBS approach will either falter because of this unmet need for national planning, or will ultimately stimulate the establishment of such a function.

In my opinion, there needs to be either an agency in the Executive Office of the President, or a permanent National Commission, or both, charged with the responsibility for national development planning.

Such an agency or permanent commission would, in my opinion, provide the best basis for guiding the application of systems approaches to the pressing domestic issues facing this Nation.

The first of these is manpower. Our State PPBS, because of its dominant emphasis on the need to link the broad comprehensive and functional policy planning process with the budgetary decisionmaking process, has touched off a major hunt for people who are capable of high level policy planning, evaluation, and coordination.

Our central planning and budgeting staff agencies are constantly being raided by our own line agencies, and our present staff level is so critical that we will begin, next week, to mount what will probably be one of the largest, nationwide recruiting drives for high level professional planners and public administration experts.

In the first instance, it is these people we need, rather than the technical systems analysts and model builders. We need well-educated, inquisitive, creative planners and public administration specialists who are people oriented rather than machine oriented.

The wider their range of interests, the better. They need to have a deep understanding of our democratic federal system of government, and an intense desire to make our government institutions true reflections of society acting in the collective interests of man. They need to be sensitive to human problems. They must read well, they must speak well. They must be able to negotiate and influence others.

Systems approaches to the government's domestic problems must be organized and guided by such talented planners and public administrators. However, they should also have some basic understanding of the immense capabilities of the computer, and of the statistical and other simulation techniques of the systems engineer and operations research analyst.

It is rare that one finds such a person coming straight out of college or graduate school. While the planning and public administration schools are, on the whole, producing much better basic material these days, the fact of the matter is that leadership in systems approaches calls for some practical seasoning in the day-to-day experience of the bureaucracy.

We feel we should seek ways to better utilize the talent which is already present in our government institutions.

I recently completed a feasibility study on midcareer education for comprehensive planning. The report will be published shortly by a group of consultants working with private foundation support on detailing a suggested plan for implementing the President's proposal for a National Urban Design Institute.

My recommendations call for an early identification, after some postentry experience, of potential leaders in comprehensive planning and public administration, and offering such people the opportunity to participate in an intensive 2-year work-study program which would be designed to both broaden their field of knowledge beyond their basic specialty, and to update and train them in the most modern techniques of planning and public administration.

The students of such an institute would spend part of their time working on actual problems for actual governments or other agencies contracting with the institute for such services. They would be paid a salary commensurate with their potential earning power as a full-

time employee of the government or corporation from which they were selected.

It appears that such a program could be financed almost completely by both contributions from the student's sponsoring government (contingent of course upon his agreement to return to that government or organization for a specified time following his completion of the program) and from the proceeds of the institute's contractual agreements with government's and other agencies desiring its services. Some small additional foundation or Federal grant assistance would probably be required.

Secondly, we need the technical manpower support for applying computer technology to planning and decisionmaking. I am not speaking of people who know how to operate the hardware or do the actual programing, but of professionals from the various disciplines such as economics, sociology, geography, education, penology, et cetera, who have had additional education in systems techniques.

I believe this training should be at the graduate level. In New York, the State government contributes to the cost of such continuing education required by its employees on a simple plan that takes into account the relation of the course to the employee's work activities and the grade he receives in the course.

At this point I would like to insert that I think there is a role here for the universities and private industry in developing new techniques for programed instruction. These are self-instructing techniques whereby manuals are prepared which individuals can study and use to test themselves using automated teaching procedures. Systems techniques are particularly adaptable to programed instruction.

I think we ought to try to bring together some of our major data processing firms, such as International Business Machines and other such groups in the country, with the government officials and the university faculties concerned with producing this type of individual and see if some basic curriculum material and program instruction methods couldn't be worked out.

Senator NELSON. May I interrupt a moment?

Is New York going to undertake this kind of a training program?

Mr. MOORE. Yes, we are. We do have an item in our budget this year to investigate the educational aspects of technological applications to our functional planning.

Senator NELSON. Have you outlined a course?

Mr. MOORE. Basically what we want to do is have a series of what you might call brainstorming sessions related to various functional or a specific functional problem area, to discuss what the relationships should be between the variables contributing to the development of such a system, such as a park and recreation system, and determine exactly what goals and objectives we would like to accomplish in terms of planning an integrated State recreation network.

We would have people trained in computer applications to analysis audit these sessions and later respond with a discussion of where the computer techniques could be applied to this functional area.

We think that this training has to take place related to the real world problems which our staff planners are facing.

Senator NELSON. I think this is a very creative idea and a very valuable one. If I understand you correctly you are going to identify

by some technique or another potentially valuable public employees who are now in service who have a capacity to become planners of one kind or another.

Mr. MOORE. That is right.

Senator NELSON. Then you said you would have a 2-year work-study program. Are they going to stay in the job they have now?

Mr. MOORE. This program, the one you are referring to, Senator, was one I proposed in connection with the development of the proposed National Urban Design Institute. The State at this point is not considering such a program. I just offered it as an approach which might be considered. I believe the best place to begin this would be at the national level.

Senator NELSON. Oh, I see. Well, maybe the dean of the Graduate School of Industrial Administration at Carnegie Institute may comment on this. I think they are running a course there now that does have Federal employees out of the Bureau of the Budget and various agencies. A course in systems engineering and analysis concepts. I thought you were talking about reaching into State services, selecting the best talent, and training them.

Is that what you are working on?

Mr. MOORE. If such an institute would be available to conduct this program, I am sure that we would be interested in identifying our key employees and contributing to their education in such a program.

Senator NELSON. Thank you.

Mr. MOORE. Now, our second major priority is the improvement of the information base for planning. Our PPBS efforts have at least demonstrated how weak our information base is. Before we can deal with the data needs required by refined systems approaches and cost-benefit studies, we need to establish regional planning data banks which can continually update our inventories of population composition and distribution, economic structure, land use, housing conditions, and the like.

Systems approaches to ad hoc functional areas are not likely to contribute to the solution of our domestic problems if each application draws from separate sources for the basic central data required by each of them.

In New York, Governor Rockefeller recently proposed the establishment of such a central planning data bank to be utilized for systems analysis services and approaches to planning by the State and local government units. The Office of Planning Coordination and the Division of the Budget are currently detailing the work program for implementing this proposal and funds have been secured in the current budget.

We visualize that this central bank will ultimately be linked to our State's regional areas by a telecommunications system which will permit the localities of the State to also plan on the same information base with the State.

It seems to us that the Federal Government should establish a similar, coordinated network of data banks which could be tied in with such State systems.

Our third problem is the need for more intensive efforts in research into our domestic problem areas—particularly into urban problems. Millions of dollars are being poured into the preparation of local and State development plans.

These plans, if they are to be truly effective instruments to guide decisionmaking, need to have a more adequate research base and the research, like the plan, must be a continuing process.

It is extremely difficult to achieve an optimum level of sustained research activity at the State and local government levels. The fiscal resources of the States and local governments are far too scarce to be allocated to research at the needed level. Operating programs providing direct services must be funded first.

Yet proper research investment can ultimately lead to savings through more efficient program operations.

The Federal Government could do two things:

First of all, it could insure that the tremendous research actvity of the Federal departments and agencies under the stimulation of the Federal PPBS is regularly coordinated and communicated to the central planning and budgeting staffs of the States and local government.

Secondly, it could provide greater recognition and more fiscal support for research activities related to the preparation of the State plans required by various Federal grant programs.

I would like to make two additional comments in conclusion.

Systems analysis as I have noted before and as I have observed from other testimony at these hearings, is not the central question here. Systems analysis is a tool for a process and it is a contemporary tag for an element of the comprehensive and functional planning process. The Nation's planning schools were training "systems analysts" before the commercial electronic computer existed. Science and computer technology are undoubtedly providing the professional planner with far more powerful tools than ever before and he has been quick to use them.

The transportation studies, such as the transportation studies taking place in New York State and elsewhere were using systems techniques. Simulation techniques are being applied more and more to other government planning programs. Many of these approaches have no basis in the systems engineering work of the aerospace industry and many preceeded aerospace applications.

It would be unfortunate for democracy if we allow our fascination in these new powerful tools of science to obscure the greater need for people-oriented professional planners and Government institutions to conduct the comprehensive policy planning so desperately needed.

From my own surveys of the PPBS activity at other State and local government levels, I would say that there is definitely some danger of this at the present time. In many areas, professional planners have been shut out of participation in this process primarily because of the emphasis on program budgeting and the location of this activity nationally in the Bureau of the Budget.

Most State and local budget agencies are a far cry from the orientation and depth of professional talent and expertise of the Federal Bureau of the Budget.

The increasingly developmental role of the American Government institution has brought a new climate of public opinion concerning planning. State governments are moving rapidly and local government planning is almost universal in our urbanized areas.

Yet we are still without a comprehensive planning agency at the national level to establish firm national development goals and poli-

cies. To suggest that the States can coordinate Federal programs does not serve the national interest, because the national interest is greater than the sum total of State and local government interests.

Senator NELSON. Excuse me one moment. You are suggesting that there ought to be a comprehensive national planning agency of some kind?

Mr. MOORE. Yes, Senator.

Senator NELSON. Have you given any thought to what is composition would be?

Mr. MOORE. Yes, sir. Let me complete this.

Senator NELSON. Yes, go ahead. Finish your statement.

Mr. MOORE. The States cannot effectively coordinate Federal program activities even within their own jurisdiction.

The Federal Department of Housing and Urban Development cannot, in my opinion, coordinate Federal program activities effectively. Coordination supposes the existence of explicit development goals and policies as a basis for coordination. HUD lacks the authority to establish and continually update national development goals and policies, nor does it have effective disciplinary powers over other Federal agencies.

The Bureau of the Budget has such disciplinary powers, but its basic concerns and responsibilities for financial planning and Federal budget execution do not, in my opinion, provide it with sufficient scope to conduct a long-range national development planning process which would seek to guide and coordinate State and local government planning in the overall national interest.

Indeed, the Federal PPBS approach will either falter because of this unmet need for national planning, or will ultimately stimulate the establishment of such a function.

In my opinion, there needs to be either an agency in the Executive Office of the President, or a permanent National Commission, or both, charged with the responsibility for national development planning.

Such an agency or permanent commission would, in my opinion, provide the best basis for guiding the application of systems approaches to the pressing domestic issues facing this Nation.

Senator JAVITS. Mr. Chairman, may I ask one question of the witness at this point? I have been agitating for a national commission on national goals, a preliminary commission of that character having been developed during President Eisenhower's administration under the chairmanship of Walter Wriston.

When you speak of national planning it gives me a different picture than the national goals concept because it has perhaps some element of compulsion. I am not saying that unkindly. And I just wondered do you in the rest of your paper spell that out so we have a clear picture of what you recommend?

Mr. MOORE. Perhaps, Senator, the best way I can do this is to draw the analogy to the process that we are following in New York State.

We have, as you well know, a central State planning agency, the Office of Planning Coordination, which reports directly to the Governor. One of our functions is to analyze the present way in which our State development goals are formulated. To do this we are reviewing all of our legislative statutes and our constitutional law. We are reviewing the program plans of the various State departments and agencies. We are reviewing executive policy statements.

Now, it is our feeling that up to this point there has been a highly informal, almost unconscious, and certainly fragmented process of goal development. What we would like to see is a more systemized approach to this.

I do not think that this necessarily implies compulsion. I know this has been the main criticism of national planning, but I do think that, in the intervening years between the time the National Resources Planning Board was abolished and the great thrust of postwar urban growth problems, the concept of planning has changed radically from one of static, master planning to one of what you might call process planning which seeks to improve the decisionmaking process. I believe goals have to be debated publicly, but in order to be debated publicly they must be explicit. They must be set forth in a systematic fashion.

In order to guide Government program officials we must have such explicit goal statements. These can and should be debatable. I believe we are at a point now where we can no longer consider the argument that planning is compulsion. If it is, why is the Federal Government funding such activity at our State and local government levels?

If planning is good enough for our States and local governments it is good enough for the Nation.

Senator JAVITS. May I, Mr. Chairman, ask one other question?

Senator NELSON. Yes.

Senator JAVITS. I don't want to interrupt the flow of your thinking, but it is a help to us to catch it just as you are thinking about it.

Have you analyzed Senator Nelson's bill as well as the so-called Morse-Scott bill?

Mr. MOORE. Yes, sir.

Senator JAVITS. You have. Now, again I don't want to anticipate your testimony. Can you actually tell us what you think of each specifically?

Mr. MOORE. As a general comment, Senator, I would note that the Department of Housing and Urban Development has recently revised its guidelines for State planning to allow funding of systems applications in context with the State development planning process, so from the standpoint of funding activities to bring systems analysis effort into studying our Government problems, I think there is adequate statutory base at the moment for doing this.

Now, in terms of Senator Scott's bill creating a national commission for management and public administration, I think definitely we certainly need some type of institute nationally to be concerned with the updating of management practices. But I question whether this group should do all of the systems approach work. I really support the idea that the States and local governments participate by doing some of this, I think they are capable of doing it.

Senator JAVITS. Do you wish wish to have an opportunity to submit for the record a detailed statement on both bills?

Mr. MOORE. We would like to send something down later, Senator.

Senator JAVITS. Mr. Chairman, I ask unanimous consent that the reply to this question may be supplemented by a written statement.

Senator NELSON. Certainly, it will be put in the record.

(The supplemental statement subsequently supplied for the record follows:)

SUPPLEMENTAL STATEMENT OF VINCENT J. MOORE, ASSISTANT DIRECTOR, OFFICE OF PLANNING COORDINATION, STATE OF NEW YORK, ALBANY, N.Y.

STATEMENT ON S. 430 AND S. 467

To review, S. 467 would create a federal commission to conduct a feasibility and applications development study of systems analysis and other management techniques to the problems of major functional areas of government. The commission would exist under this statute for some 32 months and its first year of operations would be supported by $500,000 appropriated by this bill.

Bill S. 430 appropriates $125,000,000 to be administered by the Secretary of Labor for grants to the states and direct contracting for developing and implementing systems analysis applications to national and local matters which are defined by the Secretary as "problems." No program duration is specified in the bill.

We often hear it said that, "Ever since there have been men there have been Governments which make decisions. Why should systems analysis be called in to assist with such decisions? What reason is there for such a radical change in the habits of Governments?" One thoughtful reply given by researchers at Johns Hopkins is: "The necessary and sufficient cause is the exponent growth of the progress of humanity." They also emphasize the acceleration of the casual sequence of research, innovation, and economic growth and demonstrate the absolute necessity of preliminary scientific reflection before major decisions are taken whether at the national, state, or local level. The progress of humanity is marked by the necessity to accommodate to the technological changes that are occurring at an accelerating rate. This puts a severe strain on the decision-making process. The management sciences including systems analysis and the computer can bear part of the burden. Government must assimilate these new approaches because of its key role in society, and should provide the leadership and ingenuity in using modern technology positively to design the social institutions which the complex problems of today demand. Technological progress in the past has not produced catastrophe, but has instead resulted in a higher standard of living.

This country has shown a talent for social innovation and it is important that the powerful tool of computer-based automation for production, paperwork, research, decision-making, -planning an invention be utilized to adapt to the changing times. However, research is costly. Valid perceptions of efficient, effective systems analysis do not just happen. They are the product of planning, testing, experience, observation and imagination. Very little has been done in this area at the state or municipal level. Pioneering efforts include the New York State Planning-Programming-Budgeting System and the SOGAMMIS, (South Gate Municipal Management Information System) project being undertaken by a University of Southern California team. The approach in both of these cases is a combination of functional planning, systems theory, and decision theory as it relates to resource allocation (e.g. program budgeting) and a dynamic conception of data storage, (continuous input, and random access, not a static data "bank"). Systems analysis incorporates the concept of information feedback which reflects both the performance of the governmental organization and the effect of the programs on the community being served. The significance of recent theory on the decisional processes for allocating resources (program budgeting, etc.) is particularly relevant because most if not all such theory deals with how to improve the definition of organiaztional goals and the optimal allocation of resources to them.

The expression "systems analysis" has not a single denotative universal definition, but rather it possesses several different connotations. For example, the Authors McMillan and Gonzalez, in *Systems Analysis* (Irwin 1965) include such analytic techniques as linear programming and queuing theory in the subject while many educational institutions continue to present these techniques in operations research courses. *The U.S. Government Organization Manual* lists an Assistant Commissioner for Planning and Research in the Treasury Dept. with responsibility for unspecified "systems development." The *Manual* lists a systems research and development responsibility in the Federal Aviation Agency, and

specifies the systems concerned are air traffic control and navigation. We infer, therefore, that both bills are using "systems analysis": in its most all-embracing sense. Because other organizations do not use the same definition of the term, it might be wise to spell out Senate meaning in the bill.

The Commission of S. 467 has a large bearing upon the aims, scope and finances of the program called for in S. 430. In fact, the S. 467-authorized study is a necessary prelude to effective program planning to implement S. 430. But a final report is not called for from the Commission on Public Management (S. 467) for some thirty months following their first meeting. In order for the output from the Commission study to be rational input to the program of systems analysis of governmental problems the Commission, Labor Department, states, and other interested groups will require more than the informal coordination we infer from the bills.

The program which would be authorized by S. 430 is only in part concerned with technical manpower. The implications of this program for inter and intra government planning, management and organization are undoubtedly of greater short range import.

Ideally, a study of systems analysis feasibility, such as that which would be authorized by S. 467 *might* become, should precede the program planning required to implement that proposed in S. 430. However, if both study and program are to proceed simultaneously there are clear needs to be satisfied by program funds. A moderate investment in regional inter-government O. R. technical meetings could offer an exchange of experience and methodolgy which is not provided by any organization at present.

Development of programmed learning materials for specific analytic methods and techniques would afford government-at-all-levels with a valuable and permanent training resource. Beyond these suggestions, the development of program requires better feasibility measures.

Clearly the need exists for the kind of encouragement on the part of the federal government which is evidenced in U.S. Senate Bills S. 430 and S. 467. The problems of employment, public welfare, education, mental health, water and air pollution, urbanization, crime, juvenile delinquency, housing, etc. can and must be solved. Just as the modern private organization can continue as a viable institution only if a substantial portion of its funds are systematically channeled into research and development activities related to its goal, public needs, and the mechanics essential to program achieving, so too must government respond to this need.

U.S. Senate Bills S. 430 and S. 467 are in essence two approaches to the same problem. It would seem to us that S. 430 would better accomplish the important goal of getting personnel at the state and local level involved in utilizing new techniques to solve problems. The result could very well be a system which would require basic changes in the way the state or local government has traditionally conducted its business. Systems planning might prove to be an important change agent in tooling government for the increasingly complicated governmental programs growing out of our urban society. Hence, state participation in the research efforts as provided in S. 430 would have considerable practical advantages. It is important that abstract theories be subjected to rigorous analysis and test. The New York State PPB System is an excellent example of the evolution of a concept which, once refined, can be the nucleus for a similar program in every state in the union. There is a substantial amount of literature about systems planning, program planning, etc. What is needed here is not a general study, but an attack on specific problems using the new analytic tools. For this reason, it would seem that the Department of Housing and Urban Development would be the logical agency to dispense these kinds of planning funds.

In essence we see this as a "demonstration" program quite analogous to the HUD model city program which seeks "to test whether we have the capacity to understand the causes of human and physical blight, and the skills and the commitment to restore quality to older neighborhoods, and hope and dignity to their people."

Senator JAVITS. I thank the Chair and thank the witness.

Senator NELSON. Thank you very much.

Senator JAVITS. Mr. Chairman, may I say, while I still have the floor, that I am personally very grateful to Mr. Moore for coming down here to testify. I am very proud of our State's forward looking progressivism in this and so many other fields and I respectfully state it

seems to me that this very enlightened approach certainly buttresses New York's claim to being the leader in this field.

I might say, in deference to our chairman, Wisconsin too has been a leader in many, many fields of social development, but I think in terms of administration and techniques of administration and planning New York has really done enormously well under Governor Rockefeller and I am very pleased, Mr. Moore, that you are here with us today.

Mr. MOORE. Thank you, Senator.

Senator NELSON. Thank you very much for your very fine statement, Mr. Moore. We appreciate your taking time to come before the committee.

Mr. MOORE. Thank you.

Senator NELSON. Our next witness is Mr. Roger Schrantz, Director of Policy Planning and Program Development, Bureau of Management, State of Wisconsin. Mr. Schrantz.

STATEMENT OF ROGER SCHRANTZ, DIRECTOR, POLICY PLANNING AND PROGRAM DEVELOPMENT, BUREAU OF MANAGEMENT, STATE OF WISCONSIN, MADISON, WIS.

Mr. SCHRANTZ. Thank you, Mr. Chairman. It is a real pleasure to be here this morning.

Senator NELSON. Roger, we are very pleased to have you here this morning. Since the State of Wisconsin undertook, I think, the first comprehensive State planning in the United States and the first planning-programing-budgeting program in the United States we appreciate having your views on the proposals that are pending before this committee based upon the experience that you have had, and your predecessors have had, in the bureau of management of the department of administration.

Mr. SCHRANTZ. Thank you very much, Mr. Chairman. I would like to express the regrets of Mr. McGowan who is unable to appear here today and it is my pleasure to have the opportunity to substitute for him. I have a prepared statement which I will read, Mr. Chairman, and perhaps abstract to some extent.

Senator NELSON. Any place that you can extemporize it might be helpful since we have one more witness following you in this morning's session.

You present it whichever way is most effective.

Mr. SCHRANTZ. I will start reading, Mr. Chairman and then I may abstract as I go along.

We in State government, especially Wisconsin State government, are watching with great interest and great concern the variety of bills being considered by the 90th Congress that would stimulate and assist State and local governments to improve their management and policy decisionmaking capabilities.

We welcome the concepts embodied in these bills, because we know that they are aimed at making State and local governments vital and creative links in the Federal system.

Senate bills 430 and 467 are among the most important of these bills. They seek to stimulate the application of modern management technology to the major and critical governmental problems of the 1960's and 1970's.

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Systems analysis techniques place these problems in such a framework of information and logic that policy decisionmakers will be able to chooose those solutions that will best serve society.

Systems analysis, as a sophisticated decisionmaking technique, will be effective only where the governmental jurisdictions have the capacity and the desire to employ systems analysis in the decision process. Effective use of systems analysis presupposes that a base of mature budgeting, planning, and management procedures have already been implemented. Equally important, systems analysis will be effective only where the policy decisionmakers are ready to embrace it, and where they understand its contributions and its limitations.

The capacity and the willingness of State and local governments to employ systems analysis techniques certainly must be a major concern of this subcommittee and the Congress itself, as S. 430 and S. 467 are being considered.

Only a thorough survey of all State and local governments, of course, will provide a comprehensive assessment to answer that concern. We believe, however, that Wisconsin along with New York State, has readied itself for the use of systems analysis, and in this regard, I would like to outline some of the major steps that the Wisconsin State government has taken in recent years to improve its management and policy decisionmaking process—in which systems analysis will eventually be an integral part.

The birth of Wisconsin's current day management and policy decisionmaking procedures occurred in 1959 under the leadership of the then Governor of the State of Wisconsin, and now chairman of this subcommittee. At the recommendation of the Governor, a consolidated department of administration was created to improve the State's management process and its policy decision concepts.

In a very real sense, the creation of the department of administration anticipated the use of modern management techniques, such as systems analysis. The statutory purpose of the department pointed to the development of a management and decision process that would eventually embrace the use of systems analysis techniques and included such directives as:

> **Present clearly defined alternatives and objectives of state programs and policies so that the state's agencies, the governor and legislature may plan cooperatively and finance the services which the state will provide for its citizens.**
>
> * * * * * * *
>
> **Help the state's agencies furnish the agreed upon services as efficiently and effectively as possible.**
>
> * * * * * * *
>
> **Assure the governor and the legislature that the services are being provided to the public at the agreed upon quantity, quality and cost.**
>
> * * * * * * *
>
> **Anticipate and resolve administrative and financial problems faced by the agencies, governor and legislature of the state.**

Shortly after the department was created it sought to modernize the State's budgeting techniques, to emphasize the primary role of the budget—that of assessing the needs of the State for governmental services, focusing on the objectives and goals of the State, and allocating State resources so as to satisfy the service needs in accord with the State's long-range goals.

At the same time pilot program budgets were developed for several State agencies to sharpen the concepts for a practical application of program budgeting theory and to test the marketability of program budgeting in the halls of the legislature. It was, I think, a successful venture.

Concurrent with the improvement of the State's budgeting techniques, a comprehensive State planning agency was created. In 1961, Wisconsin embarked on a comprehensive State planning process—one of the first States in the Nation to do so. The first phase of the comprehensive State plan was completed in 1963—providing an overall framework of comprehensive planning data and planning techniques in which specific functional plans could be prepared.

The second phase of the comprehensive plan is now nearing completion, and specific long-range plans have been prepared, such as a freeway plan for 1990, a correctional facilities plan, a health and medical facilities plan, a library facilities plan, an airport system plan, an outdoor recreation resources plan, a State office facilities plan, economic plans for eight State regional areas, and many other related planning documents.

In 1963, with full gubernatorial and legislative support, and complete bipartisan support, Wisconsin embarked on the mammoth task of developing a comprehensive program budgeting process for all State government activities and agencies. Its concept was to create a budgeting process that would enable Governors and legislators to focus their decisions on the basic purposes and objectives of government, the services that would be performed and the programs that would be carried out.

The rationale and intent of this comprehensive program budgeting effort is well explained in an article, coauthored by then Governor John Reynolds and the senate cochairman of the legislative joint finance committee, Walter Hollander, that appeared in the autumn, 1964 issue of State Government, published by the Council of State Governments. A copy of this article is attached to this statement for the further information of this subcommittee.

Senator NELSON. That attached article will be printed in the record at the conclusion of your prepared text.

Mr. SCHRANTZ. Thank you, Mr. Chairman.

The fruits of this program budgeting effort were realized in 1965, as the State's budget, framed in a program budget format, was considered and enacted by the Governor and the legislature.

Thus, for the first time, Wisconsin focused its appropriations and allocated its resources in a form that concentrated on the objectives of the State and the services that were to be provided.

Now that program budgeting was a reality, Wisconsin moved to build upon the decisionmaking base that program budgeting provided. In 1965, a program planning component was created in the department of administration, to make full use of the program budget as a planning tool and to make planning an active contributor to the policy decision process.

Several months later a management sciences unit was added to the range of services in the department of administration. Resulting in large part from the recommendations of a businessmen's task force studying State government operations, the purpose of this unit is to

stimulate the use of modern scientific techniques in managing State government activities and in formulating major government decisions.

Recently, another dimension to the budget policy decision process has been added. Massive budget documents can tend to obscure the major policy decisions implicit in the budget. As an aid for the legislature to better understand and act on the major policy areas in the budget, a series of policy papers outlining the Governor's budget policies were provided the legislature.

We found that the policy papers, which outlined the policy question, background information related to the policy area, and the Governor's policy position, have been enthusiastically received by the legislature. One leading legislator claimed that the policy papers provided him the ability, for the first time, to truly understand the policy ramifications of the budget.

Legislative budget hearings now more completely focus on the policy areas, and legislators are more able to fulfill their responsibilities as the policymaking branch of government.

Several vitally important proposals are now under consideration by the legislature. If approved—and there is great likelihood that legislative action will be favorable in most areas—these propsals will mark yet another significant step in our effort to implement a comprehensive management and policy decision process.

One proposal would comprehensively reorganize the structure of State government, reducing the number of State agencies from 90 to 26. Another proposal will create a department of local affairs and development, to add to the 10 States that have already done this, enabling the State to focus attention on the problems and potentials of its local governmental jurisdictions.

A third proposal would integrate the planning and budgeting process in State government, allowing policymakers to concentrate on one comprehensive decisionmaking instrument. Yet, another proposal would direct all State agencies to develop a planning capability within themselves, and would provide them with the financial resources to do so.

Several important characteristics have, I believe, marked our management and policy decision efforts. Among these are:

(1) It has been a continuing bipartisan effort. Wisconsin's development has been uninterrupted over the past 8 years, even though three men of both major political parties have occupied the Governor's chair in that period, and even though the political complexion of the legislature has changed several times over in those 8 years.

(2) It has been a joint executive-legislative effort. As the Reynolds-Hollander article referred to earlier states "the objectives of program budgeting—to assist policymakers more easily to weight the alternatives available—are in no way related to partisan ideologies or the relative balance of power between executive and legislature."

(3) It has focused on policy decisions rather than operations. Our concept of program budgeting is aimed at helping policy decisionmakers determine the scope and content and future of government services. All of its ingredients were shaped to implement that concept.

I apologize for what is probably an overly detailed historical description of the Wisconsin effort to develop a comprehensive management and policy decisionmaking process. While I hesitated to so

occupy this subcommittee's valuable time, I also believe it important that the firm commitment of State governments to an improved management and policy decision process be well understood. It is this commitment which triggers acceptance of the need and capacity of State governments to fully immerse themselves in the use of systems analysis.

So much for our past accomplishments. What do we plan for the future, and what problems do we see in implementing those plans.

In future years we hope to complete the development and implementation of an integrated planning-budgeting-management process, similar in many respects to the goals of the New York State government that Mr. Moore described.

Facets of our efforts will include better definition of the goals and objectives of State government, development of a sophisticated planning capacity—both in the program agencies and in the central budget-planning office, further refinements in the program budgeting process, development of a sophisticated systems analysis capability in the budget-planning office and in the major program agencies, development of an operational planning concept and capacity, development of a management information system that extracts and relates key bits of information, and the development of a program appraisal and reporting system.

While the development and implementation of most facets of our planning-budgeting-management process will be a monumental task, requiring thousands of hours of effort by skilled professionals, we believe that we have the direction and the capacity to accomplish most of our goals.

Refinement or development of a planning capacity, a program budgeting capacity, or a program appraisal system requires primarily the skills of planners and budget analysis. While able planners and budget analysts are in short supply, we have been successful in recruiting reasonably adequate numbers of qualified people, and we expect to be able to continue to do so in future years.

Quality systems analysis, however, is an extremely complex process which requires the skills of professional mathematicians, economists, systems engineers, and other diciplines which are not usually employed in State government. Our efforts so far to employ qualified systems analysts, even in very limited numbers, have been frustrated.

Wisconsin's need for systems analysis capabilities will probably have to be satisfied in a variety of ways. First, we will have to impart at least a working knowledge of the concepts and procedures of systems analysis in all policy decisionmakers and those directly involved in the policy decision process.

Second, we need to develop at least a modest in-house systems analysis capability. Third, we will need to rely in large part on the systems analysis products of private—not for profit—organizations and our State university.

Each of these ingredients, we believe, are necessary to a fully operative systems analysis process. Systems analysis infers a set of complex mathematical formulas that bewilder those unfamiliar with it.

One of your previous testifiers labeled it "the black box syndrome."

Yet system analysis was created to assist the decision process, not to make the decision. If systems analysis is to truly serve the decision

process and not replace it, then the concepts and procedures of systems analysis must be reasonably well understood by Governors, legislators, agency heads, budget analysts, planners, and others involved in the policy decision process. Systems analysis will thus be their servant, not their master.

We recognize also the need to develop at least a limited systems analysis capability within the State government structure. A modest systems analysis unit that is directly responsive to the policies of the Governor and legislature is, we believe, necessary to interpret those policies into the systems analysis studies.

The very complexity and expense of involved systems analysis studies will probably lead to the adaptation of the model of a system analysis study done by one State to the problems of another.

Yet, the systems analysis produced solution to a problem in California may not be at all appropriate to the traditions and set of circumstances in Wisconsin.

Thus, while the California systems analysis model might well be adapted to a similar problem in Wisconsin, we will need an in-house systems capability using that model to develop solutions appropriate to Wisconsin.

Finally, we recognize that many of our future system analysis studies, and certainly the more complex of these studies will need to be performed by private, not for profit, systems analysis organizations and by organizations within our State university. The immense complexities of major systems studies will, we know, demand a broad range of skills and concentrations that will extend beyond the scope of in-house systems analysts, and will require the resources of organizations offering a variety of professional skills and specialization in certain problem areas.

In recent years Wisconsin has employed the resources of private firms for major and complex management studies which, while they are not specifically systems analysis studies, are very closely related to systems analysis and use many of the same concepts.

For example, the State highway department has contracted with one of the Nation's leading management consultant firms for a multi-year, $175,000 study of the department's planning and management system. Now well underway, the study is being done in conjunction with department staff efforts, and is aimed at developing an integrated operations and management information system for the department's management and decision process. The sheer magnitude and complexity of the study and systems implementation demanded skills and attention beyond those of the department staff.

A similar study has just been started to develop a modern and efficient management information and control system in the department of public welfare. The study will be performed by another leading management consultant firm, with an equal staff involvement from the departments of public welfare and administration.

The study's objectives are to create a management information system that will supply the necessary management tools, provide timely information, employ uniform control concepts, identify cause, effect and trend, and fully integrate planning, reporting, and program control techniques.

In yet another project, Wisconsin is working with private enterprise to apply computer technology and systems analysis techniques to the State's information needs. Wisconsin has been selected by a leading electronic data processing firm for a multiyear pilot project that will evaluate the State's need for management information and design a comprehensive integrated management information system.

Private systems analysts and computer technicians will work closely with State personnel to install a selective, but yet comprehensive, information system that will serve the State's planning, budgeting, and operations processes.

In our preliminary evaluation of existing State information systems we find that, even though the State is paying enormous sums for information gathering, only a limited amount of that information contributes significantly to management and policy decisions.

Inadequate information, then, may be caused not so much by inadequate investment in necessary information gathering as it is by inadequate direction and evaluation of current information systems.

Even though an investment in a comprehensive systems analysis study of our information systems promises to produce returns far greater than the original investment, Wisconsin, along with other State governments finds such an investment impossible in this era of great financial burdens for essential State services. Federal demonstration funds that stimulated improved State information systems and developed models of information systems to guide all States would produce great benefits.

Finally, Wisconsin turns to its immensely valuable educational resource, the University of Wisconsin, for assistance in State government systems analysis, in addition to other facets of the State's management and decision process.

The hallowed "Wisconsin idea"—the joining of campus and capitol to solve serious social problems, will take on a new dimension in the coming years.

A multidisciplinary center for public policy and administration will be created under 1967 budget recommendations. This center will produce a broad spectrum of professionally trained people for governmental service, will offer a continuing education, opportunities to upgrade and update the professional skills of those now in government service, and will be a focal point through which the research skills and knowledge of the university faculty may be introduced into studies of State problem areas.

This description of Wisconsin's experiences and goals in developing a systems analysis capability to complement its management and policy decision process could be continued into yet further details and examples.

A continuation, however, would only add variations to the basic theme, a theme which states that Wisconsin and many other State governments have shaped their management and policy decision procedures and concepts in anticipation of systems analysis techniques. State governments now need a stimulus, expanded financial resources, and coordination to employ systems analysis with efficiency and effectiveness.

This testimony can perhaps most profitably be concluded with some suggestions that this Special Subcommittee on Scientific Manpower Utilization might consider as it structures S. 430 and S. 467 for congressional action.

These suggestions, in no particular order, are:

(1) Federal programs should encourage, and financially assist if possible, the development of a working knowledge of systems analysis by all those involved in the decision process. Systems analysis can be a real contributor to the policy decision process only if those making the decision understand the values and the limits of system analysis.

(2) It seems likely that the number of qualified systems analysts available in the near future will fall far short of the rapidly rising demand for them. Complex systems analysis studies, of course, require the skills that only a trained systems analyst can bring to it. Many of the concepts of systems analysis—disciplined logic, alternative seeking, information relationships—can be applied in less complex studies by personnel who have an appreciation of the governmental decision process, can apply the logic process, are comfortable with numbers, and who have received training in the basics of systems analysis.

Federal programs might well then include provisions for short-course training of limited systems analysts.

Senator NELSON. What do you mean by limited?

Mr. SCHRANTZ. I think perhaps, Senator, limited in the sense of people who have an analytical sort of mind, who are involved in the budget analysis of the planning process, who do not have the basic professional background of mathematics or economics, but who can learn how to apply some of the fundamentals of systems analysis in those areas where it will have benefit, but still short of the complex kinds of system analysis done by the more able.

Senator NELSON. You would find some value in establishing in one way or another some institutes perhaps under the direction of a university?

Mr. SCHRANTZ. Yes; very much so.

Senator NELSON. And to which budget analysts, or planners, or certain key people in the State government could go and take a course for a month, or 2 months, something like this?

Mr. SCHRANTZ. Yes. I think this would have a very great benefit. It would give these people some of the basic ideas of systems analysis. It would (1) perhaps, teach them not to be fearful of it. They would understand it to a much better extent, and (2) they would be able to apply some of these concepts and procedures in their own analytical work.

Senator NELSON. Yesterday, witnesses here speaking for the 11 associated land-grant universities in the Midwest—I think the Big 10 plus Chicago—I raised this very question of the value and feasibility of establishing some institutes which could be attended perhaps by two types of people; a 1-week institute possibly for your high level decisionmaking people who couldn't spend much more time than that, perhaps your budget director, for example, the director of the department of personnel, the director of the motor vehicle department, and the director of the conservation department, but at least a week or 10-day program to familiarize the top decisionmakers with the concept; and then an institute which could be attended by the middle level

executive underneath the department head, a 1-month or 6-week institute. The testimony of the two representatives of the universities yesterday was that they thought this would be a valuable course for State employees, city employees, and Federal employees.

Do you think that a 1-week course or 10-day course is of some value to be provided for your high-level decisionmaker and a 4-week course of value to a middle-level decisionmaker?

One, do you think that could be done and it would be valuable? Two, would the State of Wisconsin, for example, be interested in selecting annually and sending a certain number of middle-level decisionmakers to attend such institutes?

Mr. SCHRANTZ. I think, one, it certainly would be very valuable. I think that the concept of having various institutes for various levels of people to give them the kind of background in systems analysis which fits their appropriate decisionmaking part in the whole decisionmaking process would be valuable.

A you know, Mr. Chairman, there have been a variety of educational institutes set up on PPBS throughout the Nation. The University of Wisconsin was one which offered a 9-month academic year course for people in the Federal agencies on PPBS.

I think perhaps a more limited intensive look at systems analysis as an entity on a 6-week base, for example, for the middle-level managers, for budget analysts, for planners, and so on would have very great value and I am certain that the State of Wisconsin and the people in it would be very happy to participate and would very much feel the benefit from this.

Senator NELSON. That is one of the proposals that I think we would like to implement in this bill, recognizing the great necessity for education in this field by the very people who are making the decisions and doing the planning within their cities and State governments and Federal Government.

Mr. SCHRANTZ. This would make a very important contribution in a fairly limited way, but it would have real benefit I think to the whole decision process.

(3) Nearly all State governments should develop at least a modest in-house systems analysis capability to perform less rigorous systems analysis studies and to interpret those done by specialists for the govermental decisionmakers. Federal programs we hope will recognize this need to develop an in-house system analysis capability.

(4) Many of the most complex and perplexing governmental problems will need to be studied by systems analysis organizations that over time specializes in a limited sphere and acquire great skills and knowledge in that specialized area. We hope Federal programs will encourage the continued development of this private systems analysis capability, and its employment in solving major governmental problems.

(5) Sophisticated and efficient information systems are necessary for effective systems analysis, as well as being an integral component of effective planning and budgeting systems.

In addition, there is a real national interest in the development of comprehensive and uniform State information systems. Federal PPBS will require a complete and uniform information input from those federally aided and State operated programs. Federal pro-

grams should thus sharply encourage the development of modern information systems by State and local governments that will feed into the Federal decision process.

(6) Systems analysis is but one facet, although a very important facet, of a comprehensive decision process. It must complement and be integrated with the other facets of the decision process, such as planning and budgeting. Federal systems analysis programs, then, should be designed to work closely with other Federal programs related to the entire decision process.

(7) Complex systems analysis studies are very costly. They may well deal with social problems and subject areas that are common to many State govermnents. While the solutions advanced by a comprehensive systems analysis may be uniquely suited to a single State, its model and conceptual design may be well adapted to studies of similar problems in other States.

Federal programs should provide for a continuing coordinating mechanism that will be a focal point for the interchange of systems analysis studies among all States.

In summary, I believe this subcommittee and the Members of Congress should recognize the willingness of the States, at least I can speak specifically for Wisconsin, to assume their responsibilities in our federal system of government. We are fast recognizing that the complexities of government require sophisticated tools for enlightened and rationale decisionmaking. We recognize that the intelligent allocation of resources among competing programs and needs necessitates full utilization of the sophisticated management techniques already widely in use in the private sector.

Finally, we believe that the leadership the Federal Government can give by investing in the general upgrading of State and local governmental processes, as embodied in the bills now before you, is an excellent example of creative federalism in its finest sense.

(The paper referred to follows:)

Program Budgeting in Wisconsin

(By John W. Reynolds and Walter G. Hollander)

The enactment last June of a short, simple bill signaled the green light for Wisconsin to take a giant stride toward achieving a major improvement in state budgeting.

The measure was entitled simply *A bill relating to the development of program budgeting.* To a casual reader, it effected what might be considered a few minor technical changes in the state budget law. Its key section merely amended the law specifying the format of budget bills and appropriation requests by adding the words ". . . or other meaningful classifiations."

But the significance of this small amendment is large. It means that budget requests and appropriations no longer will have to be divided into object lines, i.e., personal services, materials and expense and capital—the things that are purchased. Rather, they will be broken down into the services that are to be performed and the programs to be carried out.

This does not imply we are going to eliminate all use of detailed items of expenditure. It does mean, nowever, that we will have the flexibility necessary to separate those items of cost detail which are important to administrators in evaluating and controlling the efficiency of their operations from those cost groupings necessary for program policy decisions which determine the nature and scope of state services.

Passage of the bill formalized the legislature's endorsement of program budgeting and propelled the state budget office (the Bureau of Management in the Department of Administration) into the final stage of its previously quiet, but deter-

mined, drive to implement this modern budgeting concept. Plans have now been completed to recast the 1965–67 biennial budget into a totally new format—with both agency requests and legislative appropriations to be structured along well defined program lines. The entire project is being done without any outside consulting assistance—a unique situation among the few states that have introduced this modern budgeting concept.

The success of these efforts, we believe, is a remarkable achievement in executive-legislative cooperation, especially because it developed and took place during a period of partisan division between the two branches.

The objectives of program budgeting—to assist policy-makers more easily to weigh the alternatives available—are in no way related to partisan ideologies or to the relative balance of power between executive and legislature. But nearly all legislative measures stand the chance of being caught up in these conflicts. Fortunately, in Wisconsin, the adoption of program budgeting did not.

How did it happen? How will Wisconsin's budget look in program form? Why do we think program budgeting is important for Wisconsin and where do we think it will lead the state? Those are the questions we hope to answer in this article. The answers should provoke thoughtful discussion and consideration of this new budgeting method, not only among government administrators and in the academic community, but also by elected policy makers in other states, and in local governments.

WHAT PROGRAM BUDGETING IS

Before seeking to answer the questions, however, it is pertinent to look briefly at the concept of program budgeting and its objectives. The term itself is somewhat forbidding to the uninitiated. What we understand it to mean is simply the casting of budget requests and appropriations into groupings on the basis of the services performed and for whom they are carried out, i.e., what is done and for whom it is done. Thus, in the Department of Public Welfare we have, as separate programs, mental health services, correctional services and family services. These describe what is done and for whom it is done. A more detailed description of the program definitions will be given later. The important thing, though, is that they describe what programs the Department of Public Welfare carries on in those areas. The dollars requested or spent in each of these areas can be weighed against the results achieved. This is certainly far more significant than determining whether an agency should be authorized another clerk, or a new typewriter, or a trip to a professional conference by a staff member.

We are not sure who originated the idea of structuring the budget and appropriations according to the programs that are to be carried out. We do know, however, that it was the highly respected Hoover Commission which, on the federal level at least, first used the term and defined its use. Its Task Force Report on Fiscal, Budgeting and Accounting Activities said that "a program or performance budget should be substituted for the present budget, thus presenting . . . expenditure requirements in terms of services, activities and work projects rather than in terms of the things bought. Such a budget would not detract from congressional responsibility and should greatly improve and expedite committee consideration."

Some confusion has apparently occurred because of the introduction of the term "performance" or "program and performance" in connection with program budgeting. They are often used interchangeably, as seen above in the Hoover Commission report. Here in Wisconsin we refer simply to program budgeting. However, we plan to introduce new techniques of performance measurement which will help administrators, the Governor and the legislature to evaluate programs better and to make more meaningful budget policy decisions. These performance measurement techniques, in our view, are not an integral part of program budgeting, but they do evolve logically out of it and enhance the entire budgeting system.

HOW IT HAPPENED IN WISCONSIN

As all experienced political practitioners are aware, major revision of a state's budgeting system does not just happen. Resistance to change in the way of doing things is one of the great stumbling blocks to any kind of major improvement in the management of government services. This fear of change exists among politicians as well as government administrators and employees. Indeed, the various interest groups which often exert strong influence on policies and practices frequently collaborate to maintain the status quo.

Breaking down this resistance to change, disolving the fear that program budgeting would mean loss of control over expenditures, and educating the various interests to the meaning and advantages of this new system did not occur overnight. In fact, this process began in Wisconsin nearly six years ago.

Initial steps

The first step was in the conversion to program budgeting of one major department—Conservation—in 1959. Financed through a segregated fund, and receiving less strict scrutiny than general fund agency budgets, this proved to be an acceptable department with which to experiment in using the new format. The Conservation Department cooperated willingly, and the interest expressed by legislators was sincere, if not enthusiastic.

This was followed in 1961 by the conversion of the Motor Vehicle Department to a program budget—again, an agency financed through a segregated fund. But that year the Board of Health was also switched over to a program budget—the first agency funded by general purpose revenues to come under the new system.

In the meantime, in 1960, the Governor had invited a group of business executives to study the state's administrative practices and make recommendations for improvement. This group split into several task forces. To each task force was assigned an administrative analyst from the state budget office. The task force on budgeting, which had an opportunity to compare the old budgeting methods with the new formats that were being developed for the Conservation and Motor Vehicle Departments and the Board of Health, recommended strongly that the state convert all agencies to program budgets.

In 1962 a legislative interim committee, charged with finding ways for improving efficiency and economy in government, recommended that we convert to program budgeting on a gradual basis. Early in 1964, a citizen's committee appointed by the legislature to examine expenditures and administrative practices enthusiastically endorsed the work that had been done toward conversion to program budgeting and urged speedy adoption of this new method.

The endorsement of program budgeting by these groups and the support they lent were major mileposts in Wisconsin's journey toward full implementation of program budgeting.

Underlying considerations

All during this same period, there was a growing awareness among individual legislators, especially the members of the Legislature's Joint Committee on Finance, that the old methods of budget review were no longer workable. While some of them understandably harbored reservations about the idea of a complete revision of Wisconsin's budget practices, many became convinced that such a step would soon be imperative. They had applauded the work of the budget office, which over the several previous biennia had considerably improved the budget document and its explanatory material. They were also impressed by the support shown for the idea by impartial citizen and taxpayer groups.

Still another factor was developing during this same period which strongly influenced legislative thinking. Over the past decade, Wisconsin's budget, like those in nearly all other states, expanded considerably, due almost entirely to rising school enrollments, increasing demands on higher education and more expensive health and welfare treatment and rehabilitation programs. Citizens expected and were being provided more state services than ever before. The trend began shortly after World War II, but was intensified as the effect of the postwar baby boom made itself apparent in the middle 1950's. As a result of these developments, state budgets grew, not only in the level of expenditures, but also in the volume and complexity of the detailed material needing review.

Assignment to Department of Administration

Because of the frustration of trying to comprehend the budget and make meaningful policy decisions in the face of this growth and complexity, the Finance Committee members decided that something had to be done to lighten their burden and make their task more purposeful. At this point, in the fall of 1963, both the Governor and the Joint Finance Committee asked that the Department of Administration take the necessary steps to proceed with full implementa-

tion of program budgeting for the 1965–67 biennium. In his directive to the Department of Administration, the Governor said:

"The recent budget session pointed out the potential for improved methods of evaluating the costs and alternatives of State government services. Many legislators have indicated a desire for a budget which clearly identifies state services and the costs, and which promotes selection of alternative program service possibilities. In addition, interested civic groups, newspaper reporters and editorial writers, and many private citizens seek the policy implicit in our present budget figures, but frequently seek in vain. What is needed is fiscal data which explains, by program, the services provided by state government."

The Joint Finance Committee in a letter to the department pointed out that ". . . When an agency presents its budget to the committee in terms of its proposed contribution to the State of Wisconsin, the Joint Committee is then able to make the most meaningful policy recommendation in terms of the wishes of the elected representatives of the people. Therefore, . . . we urge the Department of Administration to take the necessary steps to implement program planning and budgeting for all state agencies."

Fruition in 1964

Armed with these directives, the Department of Administration proceeded with an all-out effort to develop a meaningful budget format that would achieve the desired objective—to define agency programs in a way that would clearly spell out the services provided and which would facilitate more meaningful budget policy decisions by administrators, the Governor and the legislature.

To accomplish this, and to help all parties involved to understand the new concept better, agency administrators were asked to prepare program formats (with necessary subdivisions) for their entire operations. When these were agreed upon with the Department of Administration, the existing appropriations (for 1963–65) were recast into the new format. A complete prototype program budget was developed for seven separate departments. Another document was prepared, showing the program breakdown for all state agencies. These were presented to the Governor and Joint Finance Committee. For both the Governor and the committee this was the first substantive description of what had been talked about for a long time. Both endorsed the proposals enthusiastically. A short time later the program budget bill was passed.

We are now engaged in the final phase of the conversion. New forms have been developed and new instructions prepared. Agencies are currently in the process of developing their 1965–67 budget requests on a program basis.

Key factors for success

The most significant things which contributed to the success of this effort to convert to program budgeting in Wisconsin were these: (1) the budget office established a channel of open communication with the legislative appropriation committee, based on mutual respect and trust; (2) the Governor showed genuine interest and gave vital support to the project; (3) the support of ouside groups was gained by factual, straightforward explanations of the methods, objectives and benefits of program budgeting; (4) a group of highly trained, competent budget personnel was able to translate the professional jargon of program budgeting into terms which could be understood by the decision makers—the Governor and the legislature; (5) awareness grew that budget methods established in another era no longer were sufficient for today's needs.

THE PROGRAM BUDGET FORMAT

What will Wisconsin's program budget look like, and how will it improve the budget process?

Briefly the budget will simply divide each agency's total operations into major components of services—programs. This is the level on which appropriations will be made. In the budget document, and in supporting material, each of these programs will be broken down into sub-programs and activities. Following the "what for whom" rationale noted earlier, which is the basis for the major program, each sub-program will describe this relationship more specifically.

For example, using again the Department of Public Welfare, following are the subprograms that fall under the major program of family services:

A. Family Services Administration
B. Child Welfare Services
C. Services to the Blind
D. Services to the Aged
E. Aid to the Disabled
F. Special Aids to Local Units of Government
G. Aids to Individuals

These sub-programs describe what aspect of family services are to be provided to each group being served.

The remaining breakdown—by activity—answers the question "how?"; i.e., how, or by what administrative techniques will the group be serverd? Thus, under Child Welfare Services, we have the following activities:

1. Child Center (institution for emotionally disturbed, dependent and neglected children.
2. Boarding Home care for Foster Children
3. Special Projects
4. Aid to Dependent Children
5. Licensing and Direct Services
6. Community and County Services

In the budget document, each of these programs, sub-programs and activities will be described in narrative form, and data will be presented showing the level of service and results of the component parts. The requested budget will be portrayed in terms of what change, if any, is proposed in the level of accomplishment.

Another important feature of the new budgeting method is the "total funds" concept. Under it the programs will be structured not according to the source of funds which finance them, but according to the services to be provided. This will eliminate the great fragmentation which has characterized Wisconsin's budgets up to now. It will enable the Governor and legislature to review programs for their relative worth and accomplishment, irrespective of whether they are financed by general purpose revenues, agency receipts, segregated revenues or federal funds.

A new form has been developed which will serve as the primary tool in analyzing why and in what ways a proposed program will change in cost from one fiscal period to the next. Essentially, this form will categorize each of the factors which contribute to a change, up or down in the proposed level of expenditure. It will also help to identify the change in the number of people served or in the kind and quality of services provided. Use of this technique will largely eliminate excessive reliance on objects of expenditure, which could only vaguely and often inaccurately be related to proposed accomplishment.

EXPECTED RESULTS

We believe this new method of constructing budgets will produce several very important results. First of all, it will help agency administrators to carry out their budget preparation on the basis of what they hope to accomplish. Thus it will serve both as a tool for reviewing the efficiency of existing operations and their results, and also as a basis for planning future services.

A second important result, we believe, will be a substantial upgrading of the budget decision-making process. In the budget process, the Governor proposes and the legislature establishes state policy. Previously, there has been no good way for these policy decisions to be formulated. The Governor and legislature were asked to determine, simply, *what is to be bought*—in terms of personnel, services and goods. They were forced to transcribe these data into their own concepts of service level. Now they will be asked to decide first *what is to be done*—what services are to be provided to whom and at what level, and the data will be uniform for both. These significant policy decisions can only be made if the Governor and legislature are given information on a basis which encourages such decisions.

A third benefit will be a substantial improvement in the ease with which the public can comprehend, and therefore appraise, responsible government. This is very important, for only if interested citizens are able to know and understand what government is doing can they intelligently judge its value and effectiveness.

THE FUTURE OF BUDGETING IN WISCONSIN

We believe that the introduction of program budgeting will have an important effect on the quality of budget preparation and planning, and will improve the basis for sound decision making by elected policy makers. Because the programs will be structured according to the groups they serve, and will encompass the funds derived from all sources, a much more comprehensive review of the budget requests will be possible and program policy alternatives will be more readily discernable.

Where do we go from here? In a directive to the department heads, describing how the state would proceed with the implementation of program budgeting, the Governor outlined a three-part program to improve financial administration.

1. Budgets stated in terms of services to the people in order to present fiscal policies in the context of services to be accomplished.
2. Criteria to measure the cost of state services and the performance of state agencies in providing these services.
3. Organization for long-range fiscal planning to establish state goals and institute plans to achieve those goals.

The first part of the three, of course, is the implementation of program budgeting. The other two, we believe, are made possible by program budgeting and follow logically from it. Development of unit costs and yardsticks to measure the performance of state agency operations is feasible only if these operations are divided into meaningful units. The programs, with their respective subdivisions, fit very neatly into this requirement. Thus, unit cost data and performance measurement will both evolve out of and also build on the essential foundation—program budgeting.

Long-range fiscal planning and the establishment of goals for future programs is a second logical outgrowth of program budgeting. The natural extension of this, in turn, is the development of better departmental program plans and the synthesis of these plans into broad functional plans. These plans, because they are based on the programs, will further strengthen and unify the budget process.

When these things are accomplished, state government operations will not only be much more comprehensible; there will be a meaningful basis and systematic techniques for planning, reviewing, modifying and carrying out state programs. This, we think, will help both the Governor and the legislature to weigh the value and effectiveness of state government, and to balance and decide upon the essential policy alternatives available to them. It will also help interested citizens to understand and evaluate the services their state government provides.

Program budgeting is not a panacea. Neither are performance measurement and long-range fiscal and program planning. They will not, by themselves, hold down budget levels or provide better service. But if used properly they will promote better planning and better decision making.

Such a program will not only make state government more efficient, but also more responsible to the needs and wishes of the people it serves—a prime objective to all those who are interested in democratic government.

As elected representatives of opposing political beliefs, and serving two separate branches of state government, we are proud of the way in which our forces united to accomplish this significant improvement for Wisconsin.

Senator NELSON. Mr. Schrantz, I want to thank you very much for your very fine presentation. It will be very helpful to the committe in formulating legislation. I appreciate your taking the time to come down here and present your statement this morning.

Mr. SCHRANTZ. Thank you very much.

Senator NELSON. The next witness is Mr. Richard Cyert, dean of the Graduate School of Industrial Administration, Carnegie Institute of Technology.

Dean, it is very nice of you to take the time to come here today and present your statement. Your prepared text will be printed in full in the record and you may present it in any fashion you want, read it or extemporize from it, however you wish.

STATEMENT OF RICHARD M. CYERT, DEAN, GRADUATE SCHOOL OF ADMINISTRATION, CARNEGIE INSTITUTE OF TECHNOLOGY, PITTSBURGH, PA.

Mr. CYERT. Very well, I would be happy to accommodate you on that.

Senator NELSON. That is all right.

Mr. CYERT. I am prepared to come back after lunch if you want, or however you would like to operate.

Senator NELSON. We will go through the morning hour. You go ahead.

Mr. CYERT. All right. Then in the interest of time since the testimony is going to be in the record I would prefer just to make a few remarks and then maybe you have some questions and we could talk back and forth then in that fashion.

(The prepared statement of Mr. Cyert follows:)

PREPARED STATEMENT OF RICHARD M. CYERT, DEAN, GRADUATE SCHOOL OF ADMINISTRATION, CARNEGIE INSTITUTE OF TECHNOLOGY, PITTSBURGH, PA.

The bills introduced by Senator Nelson and Senator Scott make exciting reading. More directly utilizing the social and physical sciences in the management of our society is an excellent idea. As virtually any busy man can testify, there is little time to keep up with the new ideas and techniques in his area of specialty. Only the exceptional manager manages to keep abreast of all the developments relevant to his job. As long as progress is not too rapid, it will make little difference whether a practitioner does manage to "keep up." However, the last twenty years have been characterized by change both in the basic society with which we work and in the techniques with which we solve problems. It is essential that the new analytical techniques be applied to our social problems as rapidly and efficiently as they have been applied to our physical problems: getting a man on the moon, producing goods and services more efficiently, and prolonging the life and improving the health of man.

The essence of the two bills under discussion is an attempt to develop procedures for applying our increased analytic power in the solution of important social problems. Before looking in more detail at the specific proposals contained in the bills, it may be useful to examine the nature of the problems involved.

The most famous development over the past twenty years in the area of analytic management is "operations research." Much has been written about this development in popular journals. New professional journals and societies have been started, and academic programs of operations research in many schools are now available. To some it would appear that a new science has been developed which can now succeed in solving our management problems. Certainly, few would argue that operations research has not been of major help so far or that it will not continue to be of major help in the future.

Operations research represents much progress in management, but it does not consist of a single tool which has only recently been invented. It does not represent something analogous to penicillin or another antibiotic in medicine. Operations research is a name for a set of techniques and, even more, an attitude. An operations research man is one who knows a number of these techniques and is willing to tackle problems with these techniques that were previously solved by someone making a judgmental solution. These techniques are many and varied. They include linear and non-linear programing, statistical analysis, queuing theory, computed simulation, and other techniques that are even now being developed in response to specific problems. Most of these techniques have been known for some time—even before the name, operations research, was developed. The techniques, however, became powerful methods for helping to solve practical problems only with the flowering of the digital computer. It is the latter invention which has enabled man to create an analytic revolution.

We said earlier that attitude was as much a part of the analytic progress as techniques. Specifically, we mean that with the tools a new group of individuals, some trained in the social sciences, some in mathematices, others in

engineering and the natural sciences, turned their attention to the problems of management. This group was not content with problem solutions that developed out of the judgment of experience. They wanted to develop mathematical models which encompassed the variables used by men of experience and derive an optimum—a best solution. Traditional management problems of inventory control, of advertising, of investment, and many others were subjected to an analytic approach. In all these areas of business management the aim was to reduce and to eliminate business judgment.

Someone once defined a successful manager as a man who somehow managed to guess right most of the time. The manager is continually faced with situations where there are not enough facts, or techniques for organizing the facts, to lead him to confident judgments. The manager must develop a "feel" for what is correct. But the best intuition is not as good as a comprehensive analysis of the problem. Operations research has been a process of analyzing some of these problems, of helping the manager to structure the facts and aid him in making the decision. The expressed goal has been one of eliminating or reducing the need for judgment in making decisions. As such, operations research practitioners must be irreverent concerning conventional wisdom and conventional ways of handling problems. Their task is the application of the theory and techniuqes of the social sciences, mathematics, engineerng, and the natural sciences to the solution of management problems.

I have indulged in this brief description of operations research for two purposes. First, I wanted to reinforce the idea in back of these bills. I summarize this idea as one involving an attempt to increase the analytic thinking devoted to some pressing social problems. Second, I want to be clear that many of the names used do not imply new and wonderful techniques but rather a group of techniques, many of which are old, and a strong analytic attitude.

We have emphasized above that the analytic techniques have been applied to management, but it is also true that many of the social sciences utilize these same techniques. Many of the problems mentioned in the two bills have been attacked by a modern, analytic approach. In many cases the research has been sponsored by the Government through the National Science Foundation. The progress, however, can be detected only by an expert who knows the literature. It is difficult to present something as concrete and universally understood as an orbiting satellite.

At the same time it is fair to say that most social scientists have been interested in understanding the phenomena of their subject matter and in explaining the behavior they observe in a scientific manner. The profession of social engineering has not developed in a manner analogous to the engineering based on the social sciences. Part of the reason for the differential development is the difference in the nature of the problems. Physical problems frequently are well-structured. A solution can be defined and one can tell when he has a solution. Social problems are usually unstructured. Many solutions are possible and one does not have a solution until agreement can be reached on the criteria that a solution must meet. Furthermore many of our most pressing social problems, especially those involving the urban area, require the use of many disciplines in their solution. None of this is meant as an apology for the social sciences. Rather it is an attempt to bring the problems into focus. The quality of our engineers and natural scientists is not better than the quality of our social scientists. The problems are different in nature. There are no magic tools of engineering or natural science that can be applied to social problems with instant success.

Having said all this I reiterate my approval of the two bills up for discussion. There must be a concerted and systematic effort made to apply the best analytic methods to the solution of pressing social problems. In particular I like the idea of forming a commission to develop operational approaches to handling the important problems. There is always the danger that another commission generates another report which occupies space and results in no action. On the other hand, there is no approach which guarantees constructive action. I would like to see a commission composed of working scientists in mathematics, statistics, economics, sociology, political science, psychology, civil engineering, mechanical engineering, and chemical engineering given the task of proposing in detail, action and research plans designed to utilize analytic methods in deriving solutions to a set of social problems. The commission would serve to encourage research in social problems by giving "seed grants" and by giving individuals a particular place in government to which to come with their ideas and the fruits

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of their work. Many imaginative ideas for dealing with society's problems have been lost simply because there was no recognized place to send the ideas. The commission should be viewed as an architectural commission laying out the paths to be followed. At the completion of such a set of plans the Congress and the Executive would be in a better position to decide which departments should be given specific tasks. We would have a coordinating plan which could fit the diverse activities together into a unified whole. We would also be in a position to view our problems as a system and would be able to take into account the impact of a proposed solution in one area on the solution in another area.

Manpower of the proper caliber is, of course, scarce for such an undertaking. Nevertheless, the opportunities are great and the necessity for action is evident. With the proper leadership the support of the academic community and the industrial corporations can be mobilized. In the long run it is clear, I believe, that it is only through such a concerted effort that we have a chance at creative solutions to our problems.

Senator NELSON. All right.

Mr. CYERT. I think that the basic notions in both these bills are good. I think I would summarize them by saying that really there is an attempt in these two bills to bring to bear on some important problems some modern analytic techniques. We have really had a significant revolution in the last 20 years in our management technology. This has been represented in improvements in the business schools.

One can look at the literature on operations research, management science, and see the fact that our whole approach to management has become much more analytic, and by analytic I mean an attempt to determine the variables that are acting on a particular system, to try to relate those variables to each other and to the variables that they affect.

Frequently this takes the form of mathematical models. Frequently the model may become so large that one wants to use the computer.

But, regardless, the point is that there is an attitude now of approaching management problems in this fashion, and increasingly I would say private management is moving into these areas and is taking this kind of approach.

There will always be judgmental factors in management, either public or private management, but I think it is incumbent upon the people working in the analytic area to reduce the areas of, say, arbitrary judgment and to develop ways of improving the kinds of judgments that are actually made.

There is a lot of progress, I think, and a lot of evidence that we are making great progress in this way, so that I see in some sense these two bills as an attempt to bring together in a particular place some power to work on this set of problems or on a set of problems.

One can specify the set, and probable needs, a little more restrictively. So I like that part in the bills. I like the attitude and I think it is in tune with our managerial technology.

Now, I think that what I would like to see on this is an attempt to get a group, whether you want to call it a public commission, or perhaps we need another phrase so that we don't just have nonworking members and honorary members of such a commission. Maybe we need another name rather than "public commission." Maybe we need to have "public work group" or something like that, but what I would like to see would be a group of people, and I tried to develop this in the latter part of my prepared statement.

I am arguing that if we could get a working group of people in a set of disciplines together giving them the task of proposing in detail

both some action and some research plans that would be designed to utilize these analytic methods to derive some solutions, I think we could make some progress.

This particular commission should have the power to give some grants, since it is not going to be able to do all of the research itself, and it should also be a place in which individuals could come with ideas and results of their own work. So I see the notion of this sort of work group as one that would lay out some plans, some blueprints—the way an architect might—and that these plans then would consist of two kinds of things.

One would be some work plans, action plans, that could be implemented immediately. Others would be research plans where the Executive or the Congress could then decide, say, which governmental departments should follow out these research plans. But we would have a coordinating set of plans as opposed to the diverse activity that we now have in many of these areas, especially those involving the urban sector. We have lots of people working on transportation, lots of people working in different aspects of housing, lots of people working in different aspects of education.

What I would like to see would be a group of working scientists from the disciplines that I have listed in my prepared statement and I don't mean to say that those are necessarily the right ones.

Senator NELSON. In that list you do not mention, as such, a systems analysis. I am assuming some of these people, some of these economists and engineers, will be people who have been working in the system analysis.

Mr. CYERT. Yes.

Senator NELSON. This is precisely what has concerned me about the problem of this bill.

Mr. CYERT. Yes.

Senator NELSON. I am sure that you and any number of people like you could enumerate some problem areas that would be fruitful to explore, some research that would be fruitful to perform. My question is, who manages the project? You suggest the right kind of people. There isn't any doubt about that. It should be a multidisciplinary group.

How do you select them and, for example, should it be full time? You can't—I am assuming—expect to set up a full-time commission of highly paid people who would take a year, or 2 years, or what have you. Would it be feasible in your judgment to create such a commission as a working commission composed of all the disciplines you mention here, assign them the task of doing exactly what you mention, pick some problem areas and probably decide, if they are going to use outside consultants, which they will, what profit or nonprofit organizations should be employed to do what kind of projects, what universities, or what have you could they contract with, what projects ought to be done? Could this be done by a group who were hired as consultants themselves on a part-time basis?

In other words, could you have them meet for a week or so as a preliminary and create some subcommittees to tackle some problems, meet again then over a period of 6 months or so and analyze the area and come up with a proposal?

Would that be practicable in your opinion?

Mr. CYERT. I think it is practicable. I was here when you were raising the notion of the possibility of doing this with the National Science Foundation. I didn't hear all of the answer, but I had some impression that that answer wasn't quite correct, because the National Science Foundation does include a large group of the social scientists of course.

I had the impression the witness was replying as though it included only the natural scientists, but I didn't hear the answer completely. I may be wrong.

It would seem to me that the notion that you had, as I understand it—I am not answering that question directly, but as one vehicle for, let's say, hiring a group of people on a consulting basis it could be done through the National Science Foundation. They would know the right people generally.

Senator NELSON. I was thinking of some established Federal institution where you house the operation, so to speak, and give it a head.

Mr. CYERT. Right.

Senator NELSON. Then I was assuming that the National Science Foundation or wherever you put it would then gather together the people you are talking about. If that were the way to do it we would authorize it or direct it by the legislation.

Mr. CYERT. Yes.

Senator NELSON. My question to you is do you think we could reach out around the country and get out of industry and out of universities the expertise that was available on a part-time basis to develop this thing and get it underway?

Mr. CYERT. I feel confident that you could. I say this because there just is great willingness on the part of people in the universities in particular, and I know also on the part of firms, to make a contribution to the solution of important social problems. It isn't necessarily just the fact that they are just great patriots. I think there is a feeling of some honor being selected for something like this.

I think there is a strong willingness among people who spend much of their time on research that does not necessarily have immediate application. The interesting thing is that the best people you see doing research, best in the sense of brightest, are generally doing research that isn't related immediately to applications. There are people studying the whole thinking process by computer simulation.

This work may not come to any practical results for 10 years, but when it does it will be very great. Well, people like this are prepared to take some time out from their research if they feel that they can really have an impact on the society. They are not prepared to partake of a boondoggle. And if you have something like this with the National Science Foundation, which has a great deal of prestige, I would feel strongly that you would be able to get the kind of groups you want and that they would be prepared to put in a great deal of time on this.

Senator NELSON. There are two bills pending before the committee. You have looked at the two bills?

Mr. CYERT. I have read both of them, yes.

Senator NELSON. The one bill proposes to create a national commission.

Mr. CYERT. Yes.

Senator NELSON. If this bill proposed to create the kind of a multidisciplinary group that you were talking about within the National Science Foundation, say, could that group perform the function that bill S. 467 proposes, that is, that a national commission would do.

In other words, without becoming full time Federal employees yearround, so to speak, could the National Science Foundation in consultation with the kind of people you are talking about do an evaluation of the overall picture, so to speak, which is the proposal as I understand it from S. 467.

Mr. CYERT. I would feel that it could. Now, the one problem that you would probably have if you had National Science Foundation people would be they are not set up to do this, that is, the National Science Foundation really is a great big research proposal processing organization.

People come in with research proposals and they process them, with the help, incidentally, of consultants. I happen to be on the screening committee for economics for instance, so I know people are prepared to give a great deal of time to these activities.

Senator NELSON. I am not saying that that is the right place to put it. I don't know.

Mr. CYERT. No, that is right, but I think that idea, the way I see it, would perform this function of the national commission as envisaged in S. 467. At least that is my thinking.

That is the direction in which I am thinking. It might also be possible, if the political situation permits it, to really have a commission of such people that would work differently from the usual national commission. In other words, maybe you could really get a working group together.

Now, I was looking at the commission recently established on the budget, on the budget procedures. You are probably familiar with that. That has a number of people that I could classify as working members. There are two people there that we had on our visits as professors at the Graduate School of Industrial Administration, and it is a high level, but I think it is a little different caliber.

One of the things that I think is important, and I say some of it in this written testimony, is that we should, I think, distinguish between the notion of having some sort of a commission or similar working group to take a look at these problems, and what kind of a systems analysis is used, the two State representatives you have been talking about, particular kinds of variants of so-called PPBS, and I think that what we need and one of the things that I like about these two bills is the ideas there is a group.

Well, at least in the one we have this notion of a group which would take an overall look at the problems, see in some sense what is already being done, see what other kinds of action programs it might recommend, and see what kinds of research that might need to be done.

I think that this coordinating activity and systemizing activity is an important thing because I have a feeling that we are going off in several unrelated directions currently in Government.

In the transportation area, just because we have a transportation research institute, I know that that is true there.

Senator NELSON. You were here, I believe, during the testimony of Mr. Roger Schrantz from Wisconsin.

Mr. CYERT. Yes.

Senator NELSON. From the Department of Administration in Wisconsin.

Mr. CYERT. Yes.

Senator NELSON. I would like to ask you the same question I asked him about the efficacy and feasibility of establishing some institutes. At Carnegie, am I not correct, you are running an institute for Federal and other employees?

Mr. CYERT. Well, for Federal specifically.

Senator NELSON. Federal employees on systems analysis.

Mr. CYERT. Yes; we were approved by the Bureau of the Budget to try to set up a program for Federal employees for essentially improving the PPBS capability within the Federal Government.

Senator NELSON. And how long an institute is this?

Mr. CYERT. What we have done is to have a year program and when we entered it we insisted on taking only a small number and being selective so that we got all of the transcripts of the proposed people and went over them before we agreed to admit them, and one of the things that we put as a requirement was a calculus background.

Senator NELSON. I didn't hear you.

Mr. CYERT. A calculus background. They had to have some work in mathematics, in other words. Then what we were able to do was to put them in the first semester in with our regular master students in management who all have this kind of background, and it turned out that the Federal people held their own very well and they added a great deal to the whole curriculum.

In the second semester they are taking five courses. Three of them are specially designed for them, one on cost-benefit analysis, one on planning and budgeting, another one on computers in government, so I think this is working out quite well. It is a year program.

Senator NELSON. A year, or 9 months?

Mr. CYERT. Nine months, yes, an academic year.

Senator NELSON. Mr. Schrantz, who is Director of Policy Planning in the Bureau of Management, thought it would be a valuable thing to do to afford some educational opportunity institutes for high-level management for maybe 10 days, whatever time they can afford like that, and a 30-day or 6-week program in the area for middle level decisionmakers.

Do you see some value in doing that?

Mr. CYERT. Yes, I am in favor of this kind if education. I think that that is separate from the specific kinds of things in the bill, but let's just talk about that for a moment.

Senator NELSON. This was just one idea that has been proposed to do out of this whole area.

Mr. CYERT. I think it is important because my general feeling, and I don't have enough concrete evidence, is that the States have been the weak spot really.

Well, the States and the cities have been weak in the terms of kinds of salary levels that they have had and in the kinds of ideas that they have had. They have become weak in their ability really to attract enough first-rate people, and I think that education can improve the kinds of people that are now there.

We have had a great deal of experience at our school with this kind of activity, post graduate education for people in private manage-

ment. We have a 9-week program and the people really are extremely enthusiastic. They go through this program; and it isn't just that we have something special. I think in general this is true of these programs. They get away from their routines. They are exposed to a lot of new ideas.

Now, the problem I think with the State people or the city people is that in a sense what you want is for them to be able to go back and in a sense do some things. You want them to be able to have greater capability to make some analyses, and I think the problem there is whether you can in fact bring up their actual capability to do something in a short period of time such as 6 weeks or even 9 weeks.

I think you can change their attitudes. I think you can make them receptive. So that I think the higher the level, the more effective one can be just because you can change an attitude in a short period of time and you can necessarily teach the technical details of a particular approach, but the people, let's say, who are on the firing line, who are going to make the analyses, it seems to me would need a longer and a different kind of education.

So that I think the distinction that you are making between high and middle level is a good one and I think in those two levels one can do a great deal with the short course sort of approach.

Senator NELSON. I certainly don't expect to make experts out of these people although with the ideas that are in the bureaucracy itself you have to develop some understanding of the new management concepts and you have to have sympathetic understanding of the people who do make decisions and who do the hiring.

Mr. CYERT. Right.

Senator NELSON. Whereas the person who takes the course and has a vista open, has an opportunity here and then has authority to hire people, will hopefully move in the right direction. That is the limit I would think.

Mr. CYERT. Right. That is the point I was going to make. The last point you make I think is an important one because if we can get people in the State and city governments with this kind of understanding they will then know the kind of people they should go after and maybe they will also then point out the fact that we have to raise some of these salaries at the State and local level in order to get the kind of people that they need. Right now I think they are just not going after them and they are just not even aware of what there is there.

Senator NELSON. I think if you looked around the country at each innovation that has occurred in a city government some place or in a State government and you trace it down, finally you find it was just one person who had an idea and pushed it.

Mr. CYERT. Yes.

Senator NELSON. And in all the type planning and budgeting work that has caught fire in the last half dozen years you could go within the Federal Government or within cities and States and you will find one person who at some stage has been exposed to the idea and pushed it.

Mr. CYERT. Yes.

Senator NELSON. I was thinking just as a limited aspect of this whole program of exposing people in city governments and State governments to what the concept is all about.

Mr. CYERT. I think that is good and I think actually you can look at an area that the Government went into, not specifically related to this, but you can see the way it affected private industry, and that is the area of quality control during World War II. The basic techniques for quality control had been developed in the 1930's, but industry had never really adopted them.

Then during the war when the Federal Government insisted on certain quality standards before they purchased ammunition or other war products, military products, then industry became interested in it and it was actually Government short courses, as well as many other private institutions that developed short courses, that developed the kind of capability in quality control which laid the foundation for the power of quality control that we now have in private industry, I feel.

There are just a multitude of short courses that grew up, many of them sponsored by the Federal Government, because they had to get this capability into industry and the people that had the technical knowledge were in the Federal Government, so I think one could do a very similar thing through these institutes sponsored by the Federal Government in appropriate educational institutions.

I think you could raise the level of the employees of the State and the city governments. So I think that is definitely an idea worth pursuing.

Senator NELSON. Your testimony is very helpful to us. We certainly will change the two bills that were introduced and our objective will be to really have a bipartisan bill that accomplishes what we are seeking to do here, and your testimony will be very valuable in finally putting that bill together.

I appreciate very much your taking the time to come to the committee.

Mr. CYERT. Thank you.

Senator NELSON. We will leave the record open for 2 weeks for additional material and the material we have on hand will be inserted in the record at this point. I want to again thank the witnesses for their fine testimony and the trouble they went to to give this subcommittee the expert help we need to produce the legislation needed in this area.

(The material referred to above follows:)

PREPARED STATEMENT OF KURT W. BAUER, EXECUTIVE DIRECTOR, SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

Senator Nelson and Members of the Subcommittee: I am Kurt Bauer, Executive Director of the Southeastern Wisconsin Regional Planning Commission. I was most pleased to receive your invitation to appear before this Subcommittee today since I believe the concept expressed in the proposed Scientific Manpower Utilitization Act to be a most exciting one with great potential benefits to our Nation and its large urbanizing regions. I am personally interested in the proposed Act since it appears to promote the same basic approach to the abatement of our most pressing urban problems as the one which has been taken by the Southeastern Wisconsin Regional Planning Commission with some success ever since its organization in 1960.

I have read Bill S. 2662, together with the published minutes of the hearings held before this Subcommittee to date on this Bill, with great interest. Much of what I have to say today will merely reinforce the testimony heard by this Subcommittee to date by providing a case study of an actual application of systems engineering techniques to the solution of the severe environmental problems facing our rapidly urbanizing society, a case study which we believe testifies to

the effectiveness of these techniques. Some of what I have to say may, however, add some new thoughts to the testimony you have heard and may possibly suggest some changes in, or additions to, the proposed Act.

REGIONAL PLANNING IN SOUTHEASTERN WISCONSIN—A CASE STUDY IN APPLIED SYSTEMS ENGINEERING

In order to place the remainder of my remarks in a proper context, it will be necessary to briefly review with you the need for, and objectives of, regional planning since an understanding of these needs and objectives is essential to an understanding of a description of the progress which has been made in the application of systems engineering techniques to urban problems in southeastern Wisconsin.

The term "regional planning," as it is used in southeastern Wisconsin, applies to comprehensive planning for an area larger than a county but smaller than the state, united by economic interests, geography, or common areawide development problems. The need for such regional planning has been brought about by certain important social and economic changes which, while national phenomena, have had far-reaching impact on the problems facing local government. These changes include: unprecedented population growth and urbanization, increasing agricultural and industrial productivity, increasing income levels and leisure time, development of mass recreational needs and pursuits, more intensive use and consumption of natural resources and development of private water supply and sewage disposal systems, far-flung electric power and communications networks, limited access highways, and mass automotive transportation. Under the impact of these changes, entire regions, such as southeastern Wisconsin, are becoming urbanized. This is, in turn, creating a host of new and intensified areawide problems of an unprecented scale and complexity. These areawide problems include, among others: drainage and flood control, inadequate water supply and sewerage facilities, rapidly increasing demand for outdoor recreation and for related park and open-space reservation, transportation, and air and water pollution. All of these areawide problems are linked to the far more basic problem of rapidly changing land use; and all are truly areawide or regional in scope, transcending the boundaries of any one municipality or even any one county. As such, these problems can only be properly resolved within the context of a comprehensive, areawide planning effort which involves the cooperation and active participation, not only of all levels of government concerned, but of private organizations and interested citizen groups as well. Thus, regional planning is not envisioned as a substitute for, but a supplement to, federal, state, and local governmental and private planning efforts. Its objective is to aid in the solution of areawide problems which cannot be properly resolved either witnin the framework of a single municipality or through single-purpose planning efforts.

The Southeastern Wisconsin Regional Planning Commission represents an attempt to provide the areawide planning and research services necessary to solve the growing areawide developmental and environmental problems of southeastern Wisconsin within the traditional framework of government in Wisconsin. It is interesting to note here that the Commission was created in 1960 pursuant to state enabling legislation by an Executive Order of then Governor Gaylord A. Nelson, presently the Chairman of this Subcommittee. Regional planning as conceived by our Commission has three principal functions to perform:

(1) The conduct of areawide research; that is, the collection, analysis, and dissemination of basic planning and engineering data on a comprehensive, uniform, areawide basis so that, in light of such data, public officials and private citizens throughout the region can better make decisions concerning community development.

(2) The preparation of a framework of comprehensive plans for the physical development of the region, these plans being directed at those functional elements and problems which have areawide significance.

(3) The provision of a center for the coordination of the many public and private planning and plan implementation activities conducted on a day-to-day basis within the region by the various levels, units, and agencies of government and by private enterprise.

The work of the Commission is thus visualized as the conduct of a continuing planning process providing many outputs of use in the making of development decisions throughout the region by both public and private agencies and to the preparation of plans and plan implementation programs at the local, state, and

federal levels. The work of the Commission emphasizes close cooperation between the governmental agencies and private enterprises responsible for the development and maintenance of land uses and for the design, construction, operation, and maintenance of their supporting public works facilities. It provides for the periodic reevaluation of all forecasts and plans produced, as well as for the extension of planning information and advice necessary to convert plans produced into action programs.

The successful performance of these three important functions—functions which we believe to be absolutely essential to the solution of any of our urban problems—is possible only through the application of systems engineering techniques. The magnitude of the information collection, analysis, and dissemination task implied by the first function; the complexity of the engineering task implied by the second functon; and the difficulty of the management problem implied by the third function all combine to make this so.

The basic problem which now faces us all and which requires the sound application of systems engineering techniques has to do mainly with the kind of environment being created by the ever increasing areawide diffusion of urban development over large regions of the earth and the relentless pursuit of an ever higher material standard of living. Regional settlement patterns have in the past been determined not by design but by economic expedience and have failed to recognize the existence of a limited natural resource base to which both rural and urban development must be carefully adjusted if severe environmental problems, including air and water pollution, are to be avoided. If increasing areawide urbanization is to work for the benefit of man and not to his detriment, adjustment of such urban development to the ability of the resource base to sustain and support it, thereby maintaining the quality of the environment, must become a major objective of all levels of government. The problems of providing economically feasible facilities for importing, diverting, and transporting potable water, sewage and storm drainage; for providing safe and rapid air and surface transportation; and for controlling pollution of streams and lakes, ground water, and air for our large urban regions will tax our existing technology to its limits. The task ahead is so great and the needs so many that only the most advanced systems engineering techniques can provide the framework within which the demands can be met.

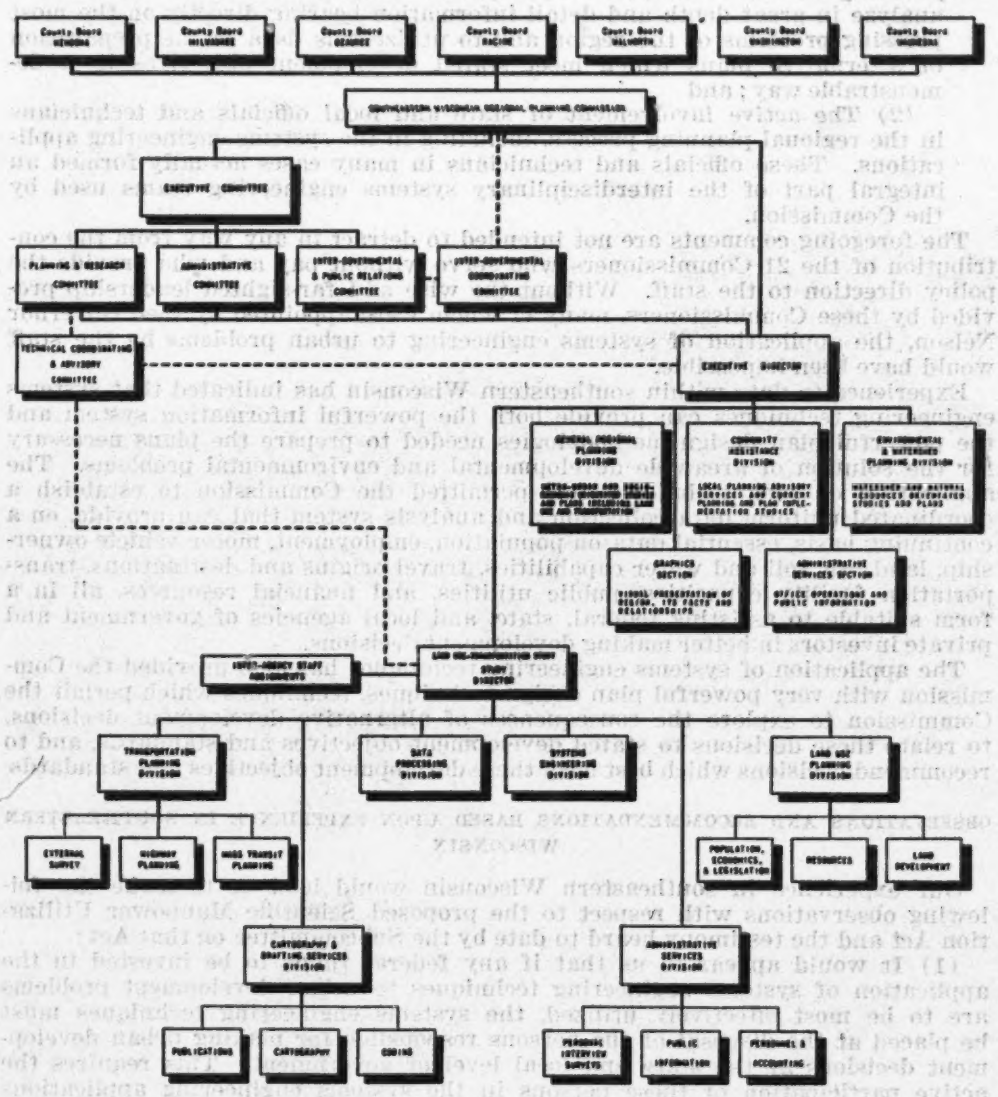
Recognizing that the aims and objectives of regional planning could only be achieved through the application of systems engineering techniques, the Commission in 1961 set about to carefully and painstakingly construct a work program which would fully utilize such techniques. The very first regional planning study completed by the Commission, a study which was—it is important to note—partially supported by a Federal Section 701 Planning Grant from the then U.S. Housing and Home Finance Agency, was a regional planning systems study. This study conceptualized four interrelated mathematical models—a socio-economic activity model, a land use simulation model, a transportation model, and a water resources model—all of which were subsequently developed and applied in the regional planning effort. These models permit the region and its principal functional relationships to be accurately described, both graphically and numerically, the complex movement of people and vehicles over highway and transit facilities and the flow of water through stream networks to be simulated, and the effect of different courses of action, with respect to regional development, evaluated. The models not only permit regional development plans scaled to future land use, travel, and resource demands and consistent with regional development objectives to be prepared but form the beginnings of a continuing planning process that permits modification and adaptation of the plans and means of implementation to changing conditions. This study also served to define the specific data requirements which would have to be met to make the models operational and permitted the Commission to structure and execute the necessary inventory programs.

The Commission early recognized that the proper application of systems engineering techniques to urban problems requires an interdisciplinary team approach in which the systems engineer, with his applied mathematical skills, is brought into day-to-day contact with specialists having substantive knowledge in depth about the problems at hand. The importance of this interdisciplinary team approach cannot be overemphasized, and in this respect we would strongly support the testimony of Mr. Thomas C. Rowan, Vice-President of the Systems Development Corporation of Santa Monica, California, given before this Subcommittee in November of 1965. In the case of a comprehensive regional planning agency,

such as the Commission, the intedisciplinary teams must include among others, in addition to systems engineers, experienced economists, demographers, land use planners, traffic engineers, sanitary engineers, hydrologists, soil scientists, foresters, fish and game biologists, architects and landscape architects, and attorneys. Moreover, these specialists must have not only an in depth knowledge of the various disciplines required on the team but also as in depth knowledge about the specific geographic area under consideration.

Fortunately, many of the substantive skills needed by the Commission could be drawn from existing governmental agencies and private corporations within the region. The Commission's committee structure and staff organization was, therefore, carefully structured to provide for not only a systems engineering division, along with certain specialists divisions, but also, as shown on Figure 1, to provide for interagency staff assignments and for technical and intergovernmental coordinating committees which would allow the knowledge of existing governmental agencies and private corporations within the region to be utilized. The advisory committees created by the Commission serve not only to place the knowledge and experience of experts within the region at the disposal of the

ORGANIZATIONAL STRUCTURE OF THE SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION AND STAFF



Commission but serve to integrate state, regional, and local development objectives, standards, and plans and build necessary support for plan implementation.

Utilizing systems engineering techniques, the Commission has to date completed a land use plan and a transportation plan for the region and is well advanced in its efforts to complete comprehensive watershed development plans for each of the major watersheds within the region. The land use, transportation, and comprehensive watershed plans produced by the Commission to date have all been well received by the agencies and units of government responsible for their implementation. For example, the Commission adopted its transportation plan on December 1, 1966; and work has already been begun by the State Highway Commission of Wisconsin and by the Milwaukee County Expressway Commission on the corridor refinement and route location studies necessary to reserve the rights-of-way for the 291 miles of freeway facilities recommended by the plan. Similarly, action has already been taken by the units of government concerned to reserve recommended parkway sites and to carry out flood plain protection and pollution abatement recommendations contained in the Commission's Root River Watershed Study, the first comprehensive watershed study to be completed by the Commission.

Acceptance of the Commission's plans may be attributed in large measure to two factors:

(1) The application of systems engineering techniques to the regional planning effort, techniques which permit the Commission to collect and analyze in great depth and detail information bearing directly on the most pressing problems of the region and to utilize this data in the preparation of alternative plans which meet stated development objectives in a demonstrable way; and

(2) The active involvement of state and local officials and technicians in the regional planning process, including in the systems engineering applications. These officials and technicians in many cases actually formed an integral part of the interdisciplinary systems engineering teams used by the Commission.

The foregoing comments are not intended to detract in any way from the contribution of the 21 Commissioners who serve without pay and who provide the policy direction to the staff. Without the wise and far-sighted leadership provided by these Commissioners, many of whom were appointed by then Governor Nelson, the application of systems engineering to urban problems by the staff would have been impossible.

Experience to date within southeastern Wisconsin has indicated that systems engineering techniques can provide both the powerful information system and the powerful plan design methodologies needed to prepare the plans necessary for the solution of areawide developmental and environmental problems. The application of such techniques has permitted the Commission to establish a coordinated uniform data collection and analysis system that can provide, on a continuing basis, essential data on population, employment, motor vehicle ownership, land use, soil and water capabilities, travel origins and destinations, transportation facility capacities, public utilities, and financial resources, all in a form suitable to assisting federal, state, and local agencies of government and private investors in better making development decisions.

The application of systems engineering techniques has also provided the Commission with very powerful plan design techniques, techniques which permit the Commission to explore the consequences of alternative development decisions, to relate these decisions to stated development objectives and standards, and to recommend decisions which best meet these development objectives and standards

OBSERVATIONS AND RECOMMENDATIONS BASED UPON EXPERIENCE IN SOUTHEASTERN WISCONSIN

Our experience in southeastern Wisconsin would lead us to make the following observations with respect to the proposed Scientific Manpower Utilization Act and the testimony heard to date by the Subcommittee on that Act:

(1) It would appear to us that if any federal funds to be invested in the application of systems engineering techniques to urban development problems are to be most effectively utilized, the systems engineering techniques must be placed at the disposal of the persons responsible for making urban development decisions at the state and local level of government. This requires the active participation of these persons in the systems engineering applications

and is best achieved, we believe, by making any federal grants through legally constituted official governmental planning and research agencies at the state and regional level.

(2) A vast pool of substantive knowledge necessary to solve our urban problems exists within government today. This knowledge must be brought together with the applied mathematical skills of the systems engineer in order to effectively solve our most pressing domestic problems. Again, this would indicate the desirability of applying systems engineering techniques through legally constituted official governmental research and planning agencies.

(3) Proper application of systems engineering techniques to urban problems requires the collection and maintenance of massive amounts of data containing substantive information about each individual urban region. This would again indicate that systems engineering techniques might be best applied through legally constituted official governmental planning and research agencies.

(4) While much fine systems engineering work has unquestionably been done by the aerospace industry, this industry has no monopoly on systems engineering talent, nor can it provide all of the substantive knowledge required to solve our urban problems. It should be recognized that much good work in systems engineering has been done outside the aerospace industry, particularly as applied to urban problems. Examples of this may be found in the development of modern traffic and transportation planning techniques and in the development of the models essential to the application of these techniques by J. Douglas Carroll, Jr., in the Detroit, Chicago, and now New York area transportation planning studies; by Alan Voorhees, a consultant based here in Washington, D.C.; and by the staff of the U.S. Bureau of Public Roads. Indeed, much of the work on transportation done by the North American Aviation Corporation for Governor Brown, as described on pages 93 through 1222 of the published minutes of your Subcommittee hearings, was an adaptation of the work done by others in the field of transportation planning and engineering and was not originally developed by the aerospace industry. Indeed, we believe it is fair to say that the California report on transportation was, at the time of its release, behind the state of the art as developed by Carroll, Voorhees, and others up to that time. Similarly, our Commission's efforts to deevlop land use simulation and design models were carried on entirely outside the aerospace industry, as were the efforts of the Harza Engineering Corporation under contract to our Commission to develop flood routing and stream pollution simulation models. It is also interesting to note in this respect that in 1965 our Commission conducted, on a demonstration basis, a systems engineering study for the City of Waukesha Water Utility, intended to develop an optimal water meter maintenance program for that utility. Implementation of this program is estimated to result in an annual savings to the water utility of about 17 percent of the gross residential water revenues, or about $70,000 per year. A private corporation within the region, Badger Meter Manufacturing Company, building on this Commission effort, has now evolved this concept into a complete water utility management system which applies systems engineering techniques to all aspects of a water utility's operations including: information handling, planning and engineering, and operational control. This company is now engaged in installing such systems for water utilities on a national basis.

(5) It should be recognized that federal funds provided by the U. S. Bureau of Public Roads and by the U. S. Department of Housing and Urban Development have been and are now being invested in systems engineering studies, particularly in the large metropolitan transportation planning programs required under the 1962 Federal Aid Highway Act. In addition to being engaged in a continuing land use-transportation study, our own Commission is presently under contract to HUD to develop a land use design model which would permit the formulation of urban development plans meeting stated development objectives and standards at a minimum cost. It would seem to us essential that any new programs be properly related to, and coordinated with, these existing efforts in order to avoid waste and duplication of effort and in order to effectively supplement the existing efforts which are certainly, due to financial limitations, inadequate. It would appear highly desirable that existing federal agencies, such as the new Department of Transportation and the Department of Housing and Urban Development; certain state agencies, such as in Wisconsin the State Department of Resource Development and the State Highway Commission; and certain existing areawide planning and research agencies, such as our Commis-

sion, be involved in any efforts to apply systems engineering techniques to urban problems at least insofar as these efforts affect either the functional or geographic jurisdiction of these agencies.

(6) We believe it is essential that urban development problems be attacked on a functional, areawide basis and that any institutional arrangements developed as a medium for the application of systems engineering techniques to the problems of our urban areas recognize this fact. Our specific recommendations relative to the Bill, as it now stands, include the following:

(1) Water pollution, drainage and flood control, water supply, protection of the natural resource base, and land development should be considered for addition to the list of specific problems requiring the application of systems engineering techniques as enumerated in Section 2 of the Bill.

(2) The Bill should provide that the needed efforts to apply systems engineering techniques to urban problems be coordinated with existing efforts of this kind and, wherever possible, supplement these efforts. Where the systems engineering efforts involve the development of new design concepts or equipment with potential nationwide application, this could be accomplished by interagency coordination at the federal level. Where the systems engineering applications involve the problems of a specific urban area, this could be accomplished by requiring that the grants be made through appropriate state and regional agencies with responsibilities in the geographc areas to be studied.

(3) Institutions, agencies, or firms to which grants are made should be required to have an adequate background in both the substantive area being studied, as for example, transportation or water pollution, as well as in systems engineering. Where the grant is concerned with a specific geographic area, the institution, agency, or firm to which the grants are made should also be required to be knowledgeable about the area to be studied.

(4) The Act should provide for adequate program control at the federal level. Such control might require the provision of an interagency technical staff which could review and monitor the research efforts. Contracts should desirably be directed at specific action-oriented outputs, including specific facility recommendations, and the effectiveness of the systems engineering application judged on the basis of these outputs.

CONCLUSION

In conclusion, we wish to indicate our support of the proposed Scientific Manpower Utilization Act. We firmly believe that the concepts expressed in this Act must be more widely applied if we are to find lasting solutions to the most pressing problems of our urbanizing society. Southeastern Wisconsin typifies the problems facing our urbanizing Nation, and we believe the concepts expressed in the Act have been applied there with some modest success. We wish to thank the Subcommittee for the opportunity to appear before it and sincerely hope our comments will prove helpful in some small way to the Subcommittee in its deliberations.

PREPARED STATEMENT OF RICHARD P. DALY, PRESIDENT, ARIES CORP., MCLEAN, VA.

From the testimony heard last week by your Subcommittee concerning bills S430 and S467, and from your comments during the hearings, I have learned of your continuing concern with the structure, organization, and operation of the systems analysis program. It occurred to me that some independent thinking on the subject might be useful to you in helping to crystallize your thoughts. Since it is important to ARIES Corporation that any program started has a maximum chance for success, I called for discussions on the subject by key staff members to distill the best of their thinking into a workable recommendation for the Committee. The criteria they establish as necessary to a good program were these:

1. The implementing organization has to be good—it has to get into operation quickly, with few start-up problems, and it has to show positive results quickly.

2. The projects undertaken have to be of a scope that can be completed and reported within a limited time, and they must produce positive, measurable results, *not* recommendations for future action.

3. The entire program must be highly visible. Systems analysis eventually and inevitably will lead to some fundamental changes in political and organizational structures. Constant public awareness of the success of the program will lead to an easier acceptance of these changes.

The first criterion led us to the conclusion that the program would have to be set up as a new organization staffed with highly motivated and competent people. To avoid administrative start-up problems, it was felt that it would be necessary to place this organization within an existing agency, reporting directly to the ranking official within that agency. The existing organization of the host would provide administrative and logistic support, allowing the new organization to concentrate on the technical and substantive problems.

The entire Federal organization was scrutinized, and the Office of Emergency Planning was determined to be the one agency that most nearly meets the operating requirements for a host agency. OEP has an existing regional organization with contacts within the executive offices of the cities and states. OEP's charter is sufficiently close to the nature of systems analysis that perhaps only minimal changes in authorizing legislation would be necessary, and existing personnel should understand the objectives of the new group.

It will be desirable to establish an advisory council of experts from government, business, and education to help set policy, to determine criteria to be used in the selection of programs to be funded, to review progress, and to concur on the final report to Congress. The programs selected will have to be ones that can be completed and reported upon during the life of the study. Positive results will give al participants a feeling of accomplishment and lead toward rapid acceptance of systems analysis as a method. Studies that recommend more studies can lead to a sense of frustration and inhibit acceptance of advanced methods.

It is necessary, to get the program started, for local officials to generate project ideas utilizing the systems approach. In order to start this generative process, the new office should be authorized to conduct seminars and workshops, and other forms of training, for regional, state, and local officials. Such a preliminary training effort might be contracted to private firms, or universities, or some combination as best suited the needs of the people who are involved.

The crucial importance to wide popular support for the program means the responsibility for dissemination of information concerning the program must remain at the Federal level, supplemented by local efforts. Dissemination of information about the program should be geared to informing not only the technical and political leadership of progress of the program, but also the decision-influencing public—the informed citizen and taxpayer. Only in this way will there be achieved the total support necessary for systems analysis to grow to its full potential as a management tool.

PREPARED STATEMENT OF RICHARD E. ENGLER, JR., HUMAN SCIENCES RESEARCH, INC., MCLEAN, VA.

THE SYSTEMS APPROACH AND SOCIAL DEVELOPMENT

A broader view

In the expert testimony of the hearings I have noted a tendency to emphasize the "systems approach" as a bundle of specialized analytical techniques. We seem to be asking a new breed of specialist engineers whether they can plug in their technologies and generate answers to major social problems. In general, I feel the systems approach is being interpreted too narrowly. The restricted view introduces valuable tools that will be useful; but I believe a broader view can help to set in motion the social processes that will be required as we collect our tools and marshall our resources in the years ahead to resolve complex societal problems.

The view I should like to represent to the Subcommittee is one which emphasizes the broadest meaning of the "systems approach." It sees this approach as a modern-day extension of the social experiment we have been conducting on this continent since the Mayflower Compact established mechanisms for dealing with social problems. Our problems are more complex today—more difficult to comprehend and manage. Some require the application of knowledge from many specialized fields. And their complexity highlights the increasing interdependence in our day of people with the natural environment and with one another. This interdependence could often be ignored, or perhaps was accounted for unconsciously, in our social experiment in a simpler day and less populated world. Now it is the central reality bringing us to consider the

adoption of the latest methods for making sense out of the chaotic in addressing problems of man in society. Only as we are able to change and continue to correct the norms that guide social behavior will we be able to overcome the dislocations which appear as "social problems." And in the modern day, this means making people and organizations more aware of how the behavior of one is linked to the fate of all.

As we begin to attack the great national social problems with new analytic tools, we must build the human relationships and communication patterns—the institutions—for controlling and directing these tools. Actually, many of the problems will be resolved—more correctly, will be subjected to continuing correction—in the *process* through which the people and their leaders and representatives comprehend, deliberate, negotiate, reach decisions and take actions on the vital public issues. It seems safe to say that this very process will be important in the resolution of *all* social problems, although special knowledge will be more important in some problem areas than in others. For it is in the nature of social problems that the "muscle" which strengthens the societal organism is developed as the people in their communities acquire "power" to comprehend, act upon, and influence change in their life situations.

Perhaps the position I am presenting can be illustrated best by describing some differences between the type of system and the context in which the "systems approach" has been applied up to now and the type of system and context which will be emphasized in the future. I shall dramatize these differences in an oversimplified way by comparing what I shall call the "command-control model" with the "democratic model." The former model has been dominant in much of the work that has been done in implementing special-purpose man-machine systems; the latter must increasingly guide our thinking as we address social problems.

The command-control model

In the command-control model, the *special*, reflexive capabilities of a system are emphasized. The more general capabilities, for continued growth and maintenance, for example, are important; but they are secondary to the sharpening of reflexes. This type of system is like the athlete who, with the best equipment and concentrated exercise and training, develops muscles and coordination so as to be able to run faster. Or its performance resembles that of the mental gymnast who can provide swift, reliable and workable answers to specific types of problems.

An example of this type of system is illustrated by the air defense network where so many lessons of the systems approach have been learned. In air defense, we strive for a system of men and machines that detects all hostile aircraft and missiles and dispatches weapons efficiently to destroy them. The system must be adaptable to human needs and to new machines and weapons: It must "grow" and "learn" and maintain itself—and this means that there is a "social system" to be considered. But all such characteristics of the system are secondary to its reflexive capabilities to respond in a particular way to a particular type of threat.

One can imagine the human problems in optimizing reflexive capabilities of such systems. And system developers have attempted to account for these problems, although often the human participants, demonstrating great resiliency, have worked out informally their own accommodations to the gods of machine-like efficiency. A case in point is a missile system in which major human functions had been reduced to tasks of monitoring a panel of computer-generated display lights. The Air Force personnel pulling this monitoring duty reported extreme boredom; but they soon had developed games to play wtih the switches and lights, and thus whiled away their duty hours. Many also enrolled in college courses in their spare time and began to prepare for a non-Air-Force career.

The picture becomes more disconcerting when we envision a system developed around a command-control model and operating on a social problem. For example, one could foresee an efficient man-machine system performing policing functions in a large city, operating swiftly to optimize the use of resources for detection and retaliation but at the same time contributing to the incidence of crime. The weapons of retaliation could be made increasingly visible by the system, symbolizing more blatantly the hostility of those who hold power toward those who have barely a voice in public affairs. They may enforce standards that are less and less informed and open to modification by the informal rules that guide normal behavior among different groups of people. They may operate

more and more impersonally in neighborhoods, or whole communities, where personal relationships are highly valued. Their sensitivity, and their speed and standardization of response may lessen the chances for dampening minor threats to public peace and order. In these and other ways, improved reflexes can promote escalation rather than amelioration and can weaken rather than strengthen the bonds of community.

I fear that the command-control model followed too exclusively with regard to most social problems will lead us into just such vicious circles: We will become more and more efficient at alloting and dispatching resources against more and more "targets" that we will help to create and which we will be sensing by constantly improved means. (And this sounds a lot like an armaments race, doesn't it?)

The challenge to system development in the context noted above is to create a system which mobilizes resources and operates efficiently to safeguard life and property but does so in a manner which does not increase the alienation of people from their police force and from one another. For the command-control model in this context greatly limits one's view of the resources to be brought to bear on the problem. It tends to see these in terms of such things as detection devices and methods, police cars and men in uniform. Yet, in this example, the most powerful forces for enduring correction of the problem are in human resources out in the community, where people can be enabled to accept and support rules of the game of community life and come to experience justice and mutual responsibility. An efficient man-machine system may abet this process. It may also work against it, contributing to imbalances that breed more disruptive and life-negating behavior.

Certainly there is danger that our population centers, rather than becoming more viable human communities, could become arenas of many special-purpose command-control systems—commanding, albeit, greater order where formerly there was chaos, but allowing little room for human life to be affirmed and human diversity to be expressed in the give-and-take of the democratic process.

The democratic model

The systems approach guided by the "democratic model" emphasizes the *general* capabilities of a system to cope with change while maintaining continuity and stability. The system must have workable answers to current, specific problems; but its longer-range capabilities for recognizing problems and continuing to seek answers are the more important characteristics. And this is close to what the Founding Fathers had in mind with their Federal model and system of checks and balances for our society as a whole.

Following this guide promotes a process in which self-correcting methods for addressing social problems become accepted and habitual patterns of behavior—they become "institutionalized." This means that both knowledge about the social condition and the society itself develop in a continuing cycle of social experimentation, feedback and correction. It is to this end that we must find ways to make our modern systems-analytic and information processing techniques relevant. We must not let the systems approach as technique submerge the basic quest that is the American experiment. Rather, we should view it as a servant—a modern counterpart—of that experiment.

In a simpler day, Tocqueville commented on the tumult of the democratic process in American life. He wrote: "Everything is in motion around you; here the people of one quarter of a town are met to decide upon the building of a church; there the election of a representative is going on; a little farther, the delegates of a district are hastening to the town in order to consult upon some local improvements; in another place, the laborers of a village quit their plows to deliberate upon the project of a road or a public school."[1]

What he observed were the energies of men and women imbued with ideas about self government and social action to promote the general welfare. They saw these functions residing in communicating bodies of the people. As we moved westward on an untamed continent, the renewed dramas of self-government were played out at many state and local levels. The models on how to proceed were borrowed from the Philadelphia experience, as well as from prior state and local experiences people had had with self government. And of course new social and political techniques, or a particular emphasis, might appear as people encountered the particular challenges of a given time and place.

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[1] Alexis De Tocqueville, *Democracy in America*, Vol. 1 (New York: Vintage Books, 1954), p. 259.

The point I am making in discussing the "democratic model" is that in a systems approach to social development we must *consciously* address the problem of creating and energizing the networks in which *people* will process information and make decisions affecting the physical and social environment in which they live. We must consider directly how implementation of action on the problem occurs in the social system where the problem resides. At many levels (local, state, regional) where the systems approach is to be applied, we need to bring together people who will decide on rules and social mechanisms whereby a public planning and coordination process is set in motion and continually monitored and controlled. Our modern techniques for sensing, gatherig, collating and displaying information, and refined methods for organizing information so that we can comprehend complex processes, can then be servants of this process of public-policy decision making. Thus, as we design for implementation we need to ask:

Who in the community gets into the act, and how are they to be involved in providing, receiving, and processing information?

What social units for the processing of information by people—specialists and generalists—need to be created, and how should they be "checked and balanced" in the social system?

How will these units, and this system, account for such functions as: deliberation and debate; negotiation and voting; execution of decisions?

How is special expertise made relevant, and how are technical standards decided upon, enforced, modified, influenced by nonspecialists, etc.?

How is "judicial review" performed relative to the rules for operating such a system of social mechanisms?

As we address social problems we must direct major attention to setting in motion these implementation systems, allowing them to grow naturally in a distinctive region and locale and to develop and operate through their own agreed-upon rules. A given implementation system may be merely a rearrangement of existing social and political mechanisms in the locale of a social problem, or it may require true innovation—a small-scale "constitutional convention" in which new rules and relationships are decided upon.

It would appear that in this work of bringing our social experiment up to date and building in again a design for stabilization and self-correction, the talents of "systems scientists" of the type who generated our Federal model at Philadelphia—and certainly the involvement of people as citizens—are at least as important as the talents and involvement of the modern-day engineers of man-machine technologies.

Support for social experimentation

In closing, I should like to make a pitch for the intermediaries who must help gear down and make relevant the new technologies that many are waiting eagerly to plug in for the attack on social problems. I doubt that the needed transformations can be accomplished today in our traditional academic settings—for there, I fear, too little energy would flow into the process of social development. But I am equally afraid that the great business organizations with their massive technologies to feed are not geared for the needed transformations.

This seems to leave the problem-oriented institutes or other R&D organizations as prime candidates for support in experimentation with the systems approach to social problems. Should we have a counterpart to NASA or to RAND at the national level conducting or coordinating such experiments? Should such an organization effect experiments through decentralized institutes? Or should it coordinate and support research and development conducted by a broad array of private and public, profit and nonprofit organizations?

All of these options are inadequate insofar as they fail to account for the shift in emphasis in the systems approach to which I have alluded. This shift demonstrates that the most significant dimensions in social problems are the human institutions in the particular social system where dislocations have occurred. Resources for resolving the problems are present *in the locale*, and they must be mobilized and coordinated in that locale. This means that if an institute or research and development organization is to be strongly supported as an intermediary for gearing the systems approach to social development it should be actively engaged in grappling with problems within a particular region or local area. It should be *in* and *of* this social and political complex—with a mandate and commitment like that of the land-grant colleges of our agricultural days—or it should be able to work creatively with planning and action bodies that do have such a commitment.

The systems approach to social problems is clearly an experimental quest. It turns us from situations where we could work backward to "programmed" answers and toward emergent situations where our tools of analysis are servants of an exploration into the future. Even as we determine acceptable solutions to clearly defined problem conditions of the moment, programming this proximate answer (to pollution, delinquency, congested transportation, crime, etc.) is a matter of social implementation. It requires acceptance of rules and the changing of norms of behavior by the people and organizations of a community—things that cannot be readily "commanded". And as we attempt to stay on top of problems in the emergent condition of history, the weight falls even more heavily on the democratic model to guide general social development.

Long ago, Tocqueville complimented us on our zeal and ingenuity as we attacked unfolding problems of the public welfare. Now, as we attempt to modernize our ability to comprehend social complexity and make intelligent public choices, the guide to our support should be: Who is committed to the democratic process and has the zest for social experimentation? rather than: Who has the best-packaged man-machine technologies?

PREPARED STATEMENT OF JOHN S. GILMORE, SENIOR RESEARCH ECONOMIST, DENVER RESEARCH INSTITUTE, UNIVERSITY OF DENVER

My name is John S. Gilmore. I am a research economist at the University of Denver Research Institute. I am speaking as a private individual, not as a spokesman for the University and not as a spokesman for the U.S. Arms Control and Disarmament Agency (which has supported some of my research). My comments reflect observations and judgments made during recent research on the diversification experiences of defense firms,[1] and on the applicability of defense firms' systems capabilities to non-defense public problems.[2]

I

The first of Senator Nelson's questions orienting this statement was, "What is now being done?" in applying "systems approaches" to solving domestic public problems.

It seems to me that the most important thing is the inauguration of planning-programming-budgeting systems (PPBS) in Federal departments and agencies. This is at least exposing hundreds of people to systems analysis concepts. A Civil Service Commission training program is under way, and some agencies have acquired personnel with substantial systems experience to oversee and participate in their efforts.

The benefits of this PPBS effort will, hopefully, be better resource allocation, development of superior programs, and better program management. The danger is that the systems analysis phase of PPBS (including the synthesis of new alternatives) will be neglected for lack of qualified personnel. If that happens, PPBS may be remembered mainly for having imposed new paperwork and a new format on fiduciary budget documents.

At the very least PPBS serves an educational function, and may prepare governmental staff to deal with systems analysts.

It appears desirable that PPBS be extended to state and local government, many of which have had little or no thinking and planning money available except for the traditional types of land use and highway planning. Encouragingly, several state and local governments or agencies are now experimenting with PPB systems.

The most impressive use of a systems approach for specific problem solving which I'm acquainted with is in the high speed ground transportation field. The United Aircraft Corporation's new high speed train is an innovational piece of hardware resulting from systems analysis and systems engineering. These are both quite analogous to the analysis and engineering used in weapons systems work. In this same field, TRW Systems has a sizable systems engineering study under way.

Information systems for public agencies represent another field where the systems approach is important. Law enforcement information systems in California, Illinois, and New York embody substantial systems efforts. Another growing

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[1] Reported in *Defense Industry Diversification—An Analysis With 12 Case Studies.*
[2] To be reported in Spring 1967.

field is that of medical information systems, including regional medical programs being planned in close conjunction with the information systems that will serve them. Firms in these fields include IBM, Lockheed Missiles and Space Company, TRW Systems, United Aircraft, and Systems Development Corporation.

The well-known State of California systems studies of 1964–65 looked at the possibilities of applying systems analysis to governmental problem solving. The results were encouraging enough that additional studies, still on a somewhat exploratory basis, are under way by TRW Systems (land use information system), Space-General Corporation (Aid to Families with Dependent Children Program systems analysis), and Aerojet-General Corporation (waste management system). Bids have been requested on a criminal justice information system.

An interesting effort at the local level occurred when a number of California school districts aggregated their demand for new school buildings. Building Systems Development, Inc. took a systems engineering approach to designing components and modules for buildings meeting their joint requirements. These showed substantially improved benefit-to-cost characteristics over conventional structures.

It's hard to say that the systems approach is "proven" for any of these fields, except for the computer-based information systems handling masses of clerical information. However, a personal, subjective evaluation is that systems approaches can be highly appropriate for problems largely solvable with advanced technology hardware—such as high speed ground transportation. They—systems approaches—can probably be useful in governmental program planning and development; and in resource allocation, particularly in programs dealing with capital investment and grants in aid.

Finally, there is promise, but rather little experience, in using systems analysis to tackle major socioeconomic problems. Here the end products are hard to anticipate, but they may involve whole new programs and institutional relationships. The working problems are easier to foresee than the results: great gaps in available data; some data gathering and analysis techniques are more oriented to the behavorial sciences than to engineering or economics; and many imponderables about the cultural and personal values important to defining system objectives, or to setting criteria for choosing among alternative systems. The communication problems among these systems analysts will be much greater than those experienced by engineers and scientists doing weapons systems work.

These problems can be solved if systems analysis teams, combining both systems experience and experience in the environment under study, can also accumulate experience in working together. Then real progress seems likely in dealing with present and prospective socioeconomic problems.

II

Next, a question was raised about the roles and relationships of the different levels of government, the universities, and industry in systems type problem solving.

To reply with a grand oversimplification: the Federal government has the problem-solving money, state and local governments have the problems, and defense industry has most of the systems experience. And the universities have faculty members with a tradition of independence and individualism.

At least, the Federal government has generally been able to fund research and other studies oriented toward its missions and toward the problems for which it has responsibility. Some of this has been done in-house; much of the innovative systems analysis, systems engineering, and program management work required by the Department of Defense and the services has been contracted out. Furthermore, Federal agencies have set the precedent by supporting much of the conventional and highway planning done in urban areas.

In contrast, many of the major civil problems are reserved to state and local governments, but they have not developed the financial strength to solve them. They also have a poor record at advanced planning for the contingency that problem-solving money would suddenly be available. It was a rare community that was ready to use effectively Area Redevelopment Administration money or to set up community action programs when Office of Economic Opportunity funds poured out. And the central administration of these programs was also too extemperaneous to furnish adequate guidance, from what I saw of their early operations.

Generally, the cities and states aren't used to spending much "thinking money," either on staff or outsiders. They are usually hard pressed to operate existing programs. Few of them have traditions of contracting out the managerial tasks of program development and evaluation (although land planning and data processing consultants are used). These are real obstacles to adopting systems approaches at the state and local level.

In summary, states and localities have jurisdiction over many problems which are or may be amendable to systems approaches. They are not well prepared to apply these approaches in-house or to contract for them. They lack the capability to define their requirements, evaluate systems proposals, or monitor systems research.

There are limited resources available for producing good systems work, anyhow. The Federal government has been unable to fill its slots for PPBS analysts. Most of the key systems engineering people are in defense industry and/or computer manufacturing. The total number of systems engineering key men, nuclei for productive teams, is probably on the order of a few hundred to a few hundred to a few thousand. Key systems analysis people (overlapping somewhat with the systems engineers) and systems managers are probably fewer, and are found largely in defense agencies and defense industry (with the defense think tanks included somewhere between those two categories).

Generalizing, most of the experienced systems people (with experience applicable beyond information systems) are busy in defense industry. There they have spent relatively little time working with social scientists and behavioral scientists, whose interdisciplinary help is crucial in everything but the hardware aspects of most civil systems approaches. The defense-experienced systems people have excellent engineering and computational skills, but these are not wholly synonomous with the skills for complete analysis of civil systems.

The defense firms containing these systems capabilities are busy with defense and aerospace work. Except for commercial aircraft, most of these firms have had little success in substantially penetrating new markets different from their relationship with their defense customer. They (there are individual exceptions) have even less experience at devoting resources and patience to developing whole new non-defense markets—like the yet-to-be-developed civil systems market.

The universities, generally speaking, have not offered much in the civil systems field. As exceptions to this, MIT has been particularly active in transportation systems, and Stanford's engineering-economic systems graduate program is a pioneering effort. Commonly, though, university faculties don't have the key systems people, the nuclei for systems teams, alluded to earlier. Furthermore, the faculty in key schools or departments like planning and public administration are rarely systems-oriented or experienced. Planning has usually been concerned with land use and traffic. Public administration has emphasized areas like personnel, tax structure, and fiduciary budgeting rather than management budgeting (PPB).

Most universities also have an institutional obstacle to developing the interdisciplinary teams, experienced at communicating and working together, needed for systems work. In academic life, recognition comes more readily to the accomplished specialist than to the interdisciplinary team. Also, there are rarely the resources available to free the faculty time required for developing interdisciplinary competence; even if people can be found with common interest in specific civil problems and even if they are willing to accept team leaders or coordinators—the key men for systems teams.

The question remains then: how can the systems approach be brought to bear on civil problems, particularly at the state and local level?

III

Given the obstacles and problems described, some institutional changes appear necessary if systems approaches are to be brought to bear on domestic civil problems. This is particularly true where the problems are not primarily hardware problems, and where the market has a mass of state or local governmental units as buyers instead of a single customer, e.g., a hypothetical cabinet-level Department of Ocean Resources—a prospective buyer of systems services.

To make another broad generalization, the needed change would bring together Federal government money, state and local problems, and capable and experienced systems analysis, systems engineering, and program management people

(most of whom are now involved in defense work). Senator Nelson's Scientific Manpower Utilization Act (S. 2662) appears to be designed for just that purpose.

To make such a bill effective, other things need to be done. I'll conclude by mentioning three relatively minor things, and one major factor.

(1) Systems analysis and systems engineering are concepts with good reputations, which should be guarded and not oversold. There is the present danger of routine programs and proposals being dressed up by throwing in an undefined "systems analysis" phase. One remedy is for the recipient of such a proposal to require a detailed description of this phase; this should at least assure a disciplined method of measuring and comparing alternative methods of achieving the objective. Another is for the recipient to find advisors, possibly a committee of people with some systems experience in defense, electronics, or computer firms.

Eventually, though, the salary structures of government agencies will have to provide for knowledgeable and experienced systems people somewhere in the chain of program or proposal development and approval. Consultants may furnish much of this help, but some in-house competence is essential.

(2) The prospective sources of systems services should prepare now to market or supply them to state and local government customers. The primary source presently appears to be defense industry, although other firms (or non-profit groups) may acquire or develop key systems men and offer as good or better services. The universities are a potential source. Their difficulties, mentioned earlier, may be partially overcome by research institutes or interdisciplinary centers, each maintaining a nucleus of people accustomed to working with each other (and with government agencies) and calling on other interested faculty members as needed. However, few if any of these sources are apt to devote resources to accumulating experience unless support is in sight.

(3) State and local governments should prepare themselves organizationally to use a systems approach. It is obviously desirable that the problem-solving governmental jurisdiction cover the physical limits of the problem area. The Model Cities Act is somewhat concerned with this; the same philosophy should pervade other urban and regional planning activities. With fragmented local governments, some substantial institutional changes may be required.

The major institutional factor, however, is *timing*. A change like the proposed Nelson Bill must be adopted well before its benefits are expected or required. Substantial time lags are inevitable between deciding to try systems approaches and achieving their benefits.

All the above-mentioned minor institutional changes requires time. It also takes time to plan for problem-solving capital investment programs at the Federal level (e.g., the ARA and OEO experiences). It will take time for state and local government agencies to learn to use or buy systems approaches to their problem solving. It will take time for many of the sources of systems help to develop interdisciplinary systems teams, whether these sources are industrial or academic. It will take time for defense firms and universities to learn to market civil systems services. It will take time for firms without systems experience, including universities, to put together systems teams.

In conclusion, money needs to be made available for work on systems approaches to problems well before money is available for capital investment in problem solving.

It appears that problem-solving capital may be available in a few years. Either the current Vietnam costs will decline, or the economy will grow to a point where we can afford both Vietnam and some new civil problem-solving investment.

The announcement time of availability of capital will be too late to start applying systems approaches, particularly if it is a sudden announcement, e.g., one seeking to offset an unexpected cut in defense expenditures. The time lags listed above mostly involve getting ready to use the systems approach. The actual systems analysis and much of the systems engineering must also be carried out before CA Day (for Capital Availability Day). If CA Day is several years ahead of us, we need to start funding and accumulating experience on civil systems approaches now.

PREPARED STATEMENT OF DON A. GOODALL, LEGISLATIVE ACTION GENERAL MANAGER, CHAMBER OF COMMERCE OF THE UNITED STATES

The Chamber of Commerce of the United States is gratified by the interest you have demonstrated by holding hearings on proposals which, if adopted, will lead to the application of "systems analysis techniques" to the solution of public problems.

Congress over the past decade has enacted a host of programs designed to solve public, social, and economic problems. But the dimensions of these problems are staggering and becoming more complex. This is readily observable in problems relating to air and water pollution, urban transportation, core-city housing, and the like. And, it is becoming clear that these problems are not susceptible to the traditional solutions. New ways to manage the public business must be found.

For a number of years the private sector of the economy has successfully applied the techniques of management analysis to problem solving. And most recently, as the language of S. 430 indicates, the same technology has been applied to the defense sector of the Federal Government.

There is great potential for bringing the experience and expertise of the private sector to bear on the solution of social problems in the public sector. Demonstrating support of this concept, the Board of Directors of the Chamber of Commerce in November, 1966 gave their support to H.R. 17310, a bill introduced in the 89th Congress, which would establish a National Commission on Public Management. We, therefore, support an identical bill introduced in this session, H.R. 20.

At a time when financial pressures of the war are growing and the whole grants-in-aid system is being seriously questioned, the establishment of a National Commission on Public Management, rather than the enactment of yet another grant-in-aid program, would be the preferable manner for promoting the development of the application of systems analysis to public problems.

PREPARED STATEMENT OF DR. ROBERT W. KRUEGER, PRESIDENT, PLANNING RESEARCH CORP., LOS ANGELES, CALIF.-WASHINGTON, D.C.

I. INTRODUCTION

A. Purpose

The United States faces problems of unprecedented complexity as we enter the last third of the twentieth century. The swift pace of technology, population growth, and social change at home and abroad impose extraordinary problems and threats but, equally, they present entirely new horizons of human opportunity. Both the promises and dangers transcend the marketplace and require greater and greater government involvement. Governments at state and local levels as well as at the Federal level are responding—somewhat unsurely and with frequent backward glances—by expending vast sums. The sums now being spent by governments would, only a third of a century ago, have exceeded the Gross National Product. Further, governments have accepted entirely new responsibilities—to reduce poverty; to provide education with less regard to ability to pay; to reduce illness, unemployment, discrimination.

It is essential, with governments spending nearly one-quarter (about 22 percent) of the Gross National Product, that the resources be wisely used, both to avoid waste and to assure that the nation's objectives be effectively achieved. It is believed that Senate bills 430 and 467 will greatly assist in achieving this goal at the state as well as the Federal level.

As suggested in Senator Nelson's letter to me of March 13, 1967, I am submitting these written comments to the Special Subcommittee on the Utilization of Scientific Manpower for consideration of the members of that subcommittee and for inclusion in the hearing record.

My purpose in desiring to be heard is to lend support to Senate bills 430 and 467 by a group of companies that are a major factor in the performance of systems analysis and which to this point have not been heard. These companies

are the for-profit, systems analysis firms whose main function is the application of systems analysis to the problems of our day for clients in government and industry.

With regard to the strong role of systems analysis in these for-profit firms, there is an important distinction between them and the non-profits and between them and the other organization from whom you have heard. One distinction is that, certainly in the manufacturing industry, in government, and in the universities, systems analysis involves only a very small portion of the people in those organizations. Only in the case of certain non-profits such as THE RAND Corporation, from whom you have heard, does systems analysis play a pervading role.

B. Distinction among terms used

In past testimony you have heard very fine definitions and discussions of the meaning of systems analysis from representatives of several organizations. However, I would like to provide some clarification and perhaps point out some differences in meaning which I think are important and which I believe have not been presented previously.

As a general definition, *systems analysis* involves the search among a great number of alternatives or combinations of different designs for that alternative or combination that best accomplishes a certain established objective, purpose, or goal according to a certain criterion (or criteria), such as a dollar cost or the cost in terms of consumption of some other valuable resource. It is important to note that systems analysis often involves the search for the criteria and the methods for measuring cost and effectiveness in the first place.

Systems analysis, as employed by aerospace firms and by many non-profit firms that are contractually tied to the military, involve the application of techniques that are extremely valuable in problem solving. But the problems solved invariably are associated with the uses of military hardware, the selection of military hardware, and the operation of the organizations which employ them. The objectives which guide these military systems analyses are seldom, if ever, as complex as the objectives of state and local government. For the military, effectiveness rather than benefit is measured, and the goals of the research are most often clearly understood by the service or agency asking for the analysis. In contrast, the *goals* of government are more complex, are less often easily quantifiable, may be multiple, and are often inconsistent with each other. In addition, it is my belief that not infrequently in state and local government the agency responsible for a given function (and its members) are not always aware of what the goal is, or whether a goal exists, but instead continue to perform a function which is anachronistic, inefficiently performed, and often dispensable.

A systems analysis which emphasizes the alternative designs of equipment as distinguished from the other aspects of a total system, while also certainly including them, is sometimes called *systems engineering*, and indeed this is why this is why this term is more commonly used among manufacturers in the aerospace industry. However, some people in that industry use the expression *systems engineering* synonymously (in the broad sense) with systems analysis. A systems analysis which emphasizes the procedural aspects is sometimes called, particularly in the military, *operational analysis*. A great deal of what is done in the military in systems analysis is of this nature, being concerned with how best to use equipment that already exists.

Cost-effectiveness studies are a kind of simplified version of systems analysis in which the criterion chosen is most definitely cost and in which nonquantifiable considerations of, say, a political or social nature (such as acceptability) are treated separately on the side.

Planning-Programming-Budgeting (PPB) systems involve a special application of systems analysis—especially of cost-effectiveness analysis to the development of efficient, integrated programs covering a number of years. Here, the program includes the entire stream of related equipment, people, and procedures required to accomplish a certain program goal or effectiveness, with the cost of the program intimately related to the description of it.

Systems analysis could *a priori* be considered in the very broad sense (that has generally been used in these hearings) or in a very narrow sense, such as applied to a very limited field of a particular discipline (as previous testimony has noted)—e.g., the problem facing a spectroscopist in his laboratory of how best to arrange, assemble, and use the equipment he has in order to best photograph the spectra necessary for his theoretical investigation. However, here I will continue to use the broader definition of a systems analysis, wherein usually the analysis does involve a combination of at least technical, economic, and operational considerations and increasingly also involves social and political considerations; I will refer to lesser systems analysis by the expression *subsystems analysis*. Indeed, one can define various levels as subsystems analysis; in the example I gave earlier, the spectroscopist might be a "sub-sub-sub-sub-systems" analyst.

In the professional for-profit, service type of organization we all are engaged in the broad type of systems analysis like those in the non-profit organizations and we view most of the systems analysis done, say, by elements of the manufacturers in the aerospace industry, as at least one order of systems analysis below that which we do. (Some people in those industrial organizations view what we do as "super" systems analysis.) Indeed, organizations like ours are often hired by aerospace firms to complement their own subsystems analysis, in which they emphasize engineering, with our "super" systems analysis.

II. DEVELOPMENT OF SYSTEMS ANALYSIS

A. History and types of firms

Operations research, particularly operations analysis, evolved during the war and its features were used and developed, particularly by major non-profit organizations, immediately following the war into what is now known as systems analysis. The RAND Corporation was not only the principal developer, but also the earliest developer, of this approach.

Other non-profits attached to certain departments of the Government and some individual ones such as Stanford Research Institute (SRI) soon followed in this effort. About seven years after the war there emerged a number of organizations like ours, private, for-profit, purely professional-service organizations not engaged in production or laboratory development, and emphasizing the application of the systems analysis approach to the solution of important governmental and industrial problems.

The origin of the non-profits in general, as most of you know, was related to the desire to detach work done for the government from day-to-day happenings. There was also the necessity to create a vehicle for hiring the scientific-engineering talent in a highly competitive market at salaries higher than the government civil service structure would permit. These early non-profits were constituted without any attachment to hardware, and were considered, rightfully so, to have the necessary objectivity with respect to government work. However, I want to emphasize, in representing our group of for-profit, purely professional-service firms, that the latter criterion of objectivity applies equally well to for-profit firms, and that, in addition, the motivations produced by the normally constituted private enterprise ownership produce efficiencies in this work that government has come to recognize.

Development of the broader definition of systems analysis followed later in industry, and today systems analysis is primarily done by three major groups: industry, the non-profits, and the private, for-profit organizations of which we are one. Two other groups engage in a very modest amount of systems analysis—first, within the government where, of course, many people understand the systems analysis approach, but where even they, like most government people, are so saddled with day-to-day operating problems that they have little time for the more detailed analysis, and, because of this, hire for-profit and non-profit professional service firms to do this work.

The second other type is the university; it has been, I believe, generally the least likely place for systems analysis work to be done. This is because the

one principal requirement for this kind of work is the existence of a potential for easy development of a well-knit interdisciplinary team to apply this approach; the university consists primarily of individuals concerned almost entirely with their individual disciplines. Indeed, those who seek interdisciplinary activities in universities often leave to join organizations like ours and the non-profits.

B. Systems analysts available in the United States today

In order to provide the subcommittee with an approximation of the sources and number of available systems analysts in the United States, I have prepared several tables that represent our best estimates at this time. We have used the best available sources in constructing these estimates, including information developed by the National Science Foundation in *American Science Manpower, 1964* and in *Scientists, Engineers, and Technicians in the 1960's* and also by the Los Alamos Scientific Laboratory in its *1966 National Survey of Professional Sicentific Salaries.*

Some information has been obtained by direct contact with several of the firms engaged in this work. I want to point out, however, that these are only estimates, developed primarily to indicate the relative distribution of systems analysts by type of employer and that, in developing these estimates, much subjective judgment had to be exercised by the Planning Research staff.

Examination of these exhibits (see especially Exhibit 1) indicates that there are between 17,000 and 20,000 systems analysts in the United States, providing a great resource for the study of the problems faced by governments.

These systems analysts are well spread throughout the several types of employers, with non-profit organizations accounting for approximately 3,900 (about 22 percent) of the total. Of those in the non-profit organizations, an estimated 1,620 are employed by the non-profit Operating Federal Contract Research Centers (see Exhibit 2), which include Aerospace Corporation, Center for Naval Analysis, Institute for Defense Analyses, MITRE, Research Analysis Corporation, and RAND.

Over 60 percent of the toal systems analysts are employed by the for-profit type of organizations, that is, outside of government, educational institutions, and non-profits. While most of the systems analysts in the "All Other Industry and Business" category are primarily engaged in analysis related to their own industry (e.g., chemical, petroleum, automobile, etc.), the group we have shown as "Business Service Firms, For-profit" have significant-sized staffs that have had experience with a broad range of diversified studies for government and industry susceptible to the systems analysis approach.

These latter companies, most of which are shown in Exhibit 3, have staked their free enterprise existence on the conduct of the systems analysis type of work, and have grown by applying systems analysis to a broad spectrum of problems. Systems analysis is the major function of their activity. Each of the other major groups of companies we have shown in Exhibit 1 has either a minor interest in systems analysis or is supported primarily by the government.

As an example of one of these systems analysis companies, I take the one I know best—my own organization—Planning Research Corporation. Although it is one of the largest of the 21 companies listed in Exhibit 3, its growth pattern is illustrative for most of them. Planning Research Corporation was founded in 1954 with a very minimum of capital and was then regarded as a spinoff of The RAND Corporation, since all five of the founders of Planning Research, including myself obtained their experience in systems analysis at RAND. The cumulative growth rate of Planning Research over the past ten years has been 42 percent, and each year the firm has shown a profit. The corporation stock was listed on the American Stock Exchange in 1964 and currently there are more than 3,000 shareholders. At the end of its last fiscal year, the Corporation's contract revenues were $15,000,000 and current revenues, on an annualized basis, are running in excess of this figure. Planning Research employs 850 people, 600 of whom are professionals. Approximately half of the professionals are qualified systems analysts.

EXHIBIT 1.—*Distribution of scientists and engineers and estimate of systems analysts,[1] by type of employer, 1967*

Type of employer	Engineers[2]	Scientists[3]	Total	Systems analysts percent of total[4]	Estimated number of systems analysts
Business service firm, for profit[5]	14,000	[6] 7,300	21,300	15.0	[7] 3,200
All other industry and business	1,012,100	297,400	1,309,500	[8] .6	7,860
Nonprofits	[9] 7,600	24,900	32,500	12.0	[10] 3,900
Educational institutions	[9] 39,500	222,000	261,500	[11] .4	1,040
Federal Government	73,000	67,000	140,000	1.0	1,400
Other government	62,800	21,400	84,200	.3	250
Total	1,209,000	640,000	1,849,000	----------	[12] 17,650

[1] The definition of systems analysts as used herein are those scientists and engineers who are concerned with a search for preferred designs of systems by logical comparison of a variety of combinations and uses of the equipment, personnel, and procedures that comprise the alternative systems. The systems analysis includes the investigation necessary to determine the criteria by which the system may be judged. The functions of these systems analysts include:

Identify functional and operational performance requirements for new systems from analyses of defined goals, objectives, policies, and potential operational environments.

Synthesize alternative systems and operational concepts capable of meeting the identified system requirements.

Analyze the alternative systems and operations to provide the decision with comparative data on the consequences (benefits and penalties) associated with the implementation of each alternative.

Derive and evaluate initial design requirements for the preferred system to provide basic systems engineering criteria for subsystem performance selection.

[2] Source is Scientists, Engineers, and Technicians in the 1960's. National Science Foundation, NSF 63-64. Figures for 1960 and NSF's estimate for 1970 requirements have been interpolated linearly to arrive at an estimate for 1967.

[3] The number of scientists employed by each type of employer in the United States was derived from American Science Manpower, 1964, published by the National Science Foundation in 1966. Document No. 66-29, Government Printing Office.

This document indicates that 415,000 in the natural and selected social science fields in 1964 were included in the National Register and NSF believes that about 75 percent of those qualified are included (thus indicating a total of 554,000 in the United States in 1964). A compound growth rate of 5 percent per year was applied to all categories to obtain the estimates for 1967 of 640,000. The subbreakdown of industry and business—into systems analysis and software firms on one hand and all other for-profit industry on the other—are planning research estimates.

[4] These percentage estimates are based on the educated judgment of planning research personnel except where otherwise noted. However, since an approximate independent check is made on the total in 12 below these estimates are considered to be reasonable approximations.

[5] Includes firms in categories such as systems analysis, computer software, and management consultants; does not include architects and engineers.

[6] Used scientist data in source document Scientists, Engineers, and Technicians in the 1960's and interpolated to 1967 as was done for engineers; see note 2. Since these data include only the "hard" sciences, we have doubled the number to include the "soft" (social) sciences, including economists, psychologists, etc.

[7] Twenty-one major companies engaged primarily in systems analysis and software business were estimated to have in 1967 6,576 engineers and scientists and 2,025 systems analysts (see exhibit 3). It was assumed that all other systems analysis and software firms had another 2,824 engineers and scientists and 575 systems analysts, giving a grand total of 9,400 and 2,600, respectively. An additional 600 systems analysts could be attributed to business service firms other than the systems analysis and computer software types.

[8] An analysis performed by the Boeing Co. indicates that it has 26,500 scientific and engineering personnel and 250 to 300 systems analysts; this is about 1 percent. Boeing probably has a larger percentage of systems analysts than the average U.S. industrial firm. Therefore, on this basis, a value of 0.6 percent is estimated for the average U.S. industrial firm; it might in fact be 0.4 or 0.8 percent.

[9] Data for educational institutions in the source document probably includes some nonprofit organizations associated with universities such as Lincoln Labs and Willow Run Research Center. An adjustment to shift 5,000 from the educational institutions to nonprofits has been made in data from the source document.

[10] From exhibit 2, it can be seen that the six captive nonprofit companies (Aerospace, Center for Naval Analysis, IDA, MITRE, RAC, and RAND) have some 4,110 engineering and scientific personnel and about 1,020 systems analysts. This percentage of systems analysts is 39.4 percent. These companies would have a larger percentage of systems analysts than the other nonprofit corporations. (Other nonprofits would have about 8.5 percent systems analysts, based on the total number of systems analysts in all nonprofits, which is calculated to be 3,900.)

[11] This percentage estimate includes only those academic personnel who practice in the multidisciplined systems analysis more than half of their time. It excludes their relevant teaching time.

[12] The two largest professional societies that represent systems analysts are Operations Research Society of America (ORSA) and The Institute of Management Sciences (TIMS). ORSA has about 3,200 members and TIMS has about 3,100 members. It is estimated that 40 percent of these 6,300 memberships represents personnel who belong to both grops; therefore, there are 5,040 individuals represented. It is further estimated that about 50 percent of the nonduplicate society members qualify as systems analysts. Based on a small sample of organizations, it is estimated that about 1 in 8 (12.5 percent) belong to one of these two organizations. This would indicate about 20,000 systems analysts in the United States. (This exhibit indicates about 17,650.)

EXHIBIT 2.—*Estimate of scientists and engineers and systems analysts employed by nonprofit operating Federal contract research centers*

	Funds from DOD in fiscal year 1967	Total number of scientists and engineers	Number of systems analysts
Aerospace Corp.	$75, 220, 000	1, 880	350
Center for Naval Analysis	9, 300, 000	250	190
IDA	12, 400, 000	350	270
MITRE	29, 755, 000	800	200
RAC	10, 350, 000	280	210
RAND Corp.	20, 190, 000	550	400
Total	157, 215, 000	4, 110	1, 620

Sources: Funds from Hearings Before the House Subcommittee on DOD Appropriation of the Committee on Appropriations, DOD Appropriations for 1967, pt. 5, 89th Cong., 2d sess., GPO 1966, pp. 112–113.
Aerospace Corp. and RAND were contacted and figures provided on scientists and engineers and systems analysts. Others were estimated by Planning Research Corp.

EXHIBIT 3.—*Estimate of scientists and engineers and systems analysts employed by for-profit business service firms (including systems analysis and computer software firms)*

	Total number of scientists and engineers	Number of systems analysts
Total, all for-profit business service firms (including systems analysis and software firms)	9, 400	2, 600
(Planning Research Corp.)	(600)	(300)

Source: Estimate by Planning Research Corp. Includes specific consideration of each of the following 21 systems analysis and computer software firms and an estimate for "all others."

Auerbach Corp.
Booz-Allen Hamilton Applied Research, Inc.
Bissett-Berman Corp.
Bolt Beranek and Newman, Inc.
Computer Applications, Inc.
Computer Sciences Corp.
Computer Usage Co., Inc.
C-E-I-R, Inc.
Data Dynamics
Dunlap Associates, Inc.
DRC, Inc.
Informatics, Inc.
Arthur D. Little, Ltd.
Mathematica
Operations Research, Inc.
Planning Research Corp.
Technical Operations, Inc.
United Research, Inc.
URS Corp.
Vitro Corp. of America
Wolf Research and Development Corp.
All other for-profit business service firms.

C. Systems analysis applied to nondefense problems

Our organization, as well as others, has been engaged not only in systems analysis applications to defense problems over the past ten to twenty years, but also (in more recent years) in applying these techniques to problems within the civilian sector of the government. The imposition of Planning-Programming-Budgeting systems into the civilian departments of the Federal Government by Presidential order and the usefulness of systems analysis application to socio-economic problems at the Federal level are fairly well recognized.

I should like to outline three such projects for you.

1. As you know, in an effort to increase the economic rationality in the Government, the President has directed the Executive Departments and Agencies to establish systems of program budgeting.

Planning Research undertook to conceptualize a basic Planning-Programming-Budgeting system for Federal transportation activities. In doing so, Planning Research performed the following tasks:

(a) Made an inventory of over 100 Federal transportation activities and agencies.

(b) Reviewed basic legislation and Presidential policy pronouncements to establish operational statements of purposes, and, from them, to synthesize a logical and consistent hierarchy of national transportation objectives.

(c) Developed an alternative set of objectives for transportation programs.

(d) Developed estimates of transportation needs and reviewed techniques for establishing implicit and explicit goals.

(e) Prepared a prototype five-year Program and Financial Plan.

(f) Suggested measures for needs to permit comparisons between programs.

(g) Undertook rugh systems analyses of highway program constraints and of balance between highway needs and programs.

In performing the study, major transportation problems were identified, potential tradeoffs noted, and alternative program and R and D emphasis was suggested. We believe that this work, which gave an order-of-magnitude analysis for big problems, justifies the use of PPB in civilian agencies. It has set the stage for attacking big problems in greater detail as well as analyzing even broader problems.

2. Planning Research was also given the opportunity to develop cost/bentfit techniques for the Manpower Administration of the U.S. Department of Labor. A manual was written to show how to adapt cost/benefits systems analysis (within a PPB system) to manpower problems.

The manual identified several subcategories of systems analysis and applied each to an area of manpower activity. The first type of analysis identifies how much program benefits increase as expenditures are raised. There are in the U.S. Employment Service significant questions of whether this agency's present services (i.e., guidance, counseling, job development, etc.) are at optimum levels and whether USES should be serving a larger total number of job seekers, including those trying to upgrade themselves through better jobs. A systems analysis aimed at illuminating these policy questions is substantially completed.

A second type of analysis is directed at determining which of two alternative programs is the more effective for a given budget. The Manpower Administra- has a problem in determining how best to allocate funds between on-the-job training and institutional training courses. No study to date has attempted to identify all the costs (both direct and indirect) of such programs, nor all their benefits. Planning Research has undertaken an analysis that should do so to the extent available data permit. Thus, we expect to provide the basis for a sound decision.

A third type of analysis is called "cost/constraint" analysis; it identifies the cost to a program of a constraint (institutional, legal, political, or social) that may prevent the program from being most efficient. Such constraints could be union apprenticeship rules that inhibit optimal training techniques, unfavorable employer attitudes to a program, or expensive lack of cooperation among adjacent communities in furthering joint programs. Of course, identifying these costs does not reduce or eliminate them, but such identification does establish the impact of the constraints and promotes a more rational discussion with those who impose the constraints. A current Planning Research cost/constraint analysis concerns institutional constraints that seem to reduce the potential contribution of the Unemployment Compensation program to the nation's economy.

3. A recent telecommunications study for the Executive Office of the President was a typical example of the kind of support a multidisciplined team of systems analysts and economists can provide government. The Office of the Director of Telecommunications Management (a part of the Executive Office) has the responsibility for policy guidance and coordination of the telecommunications activities that take place in the various branches of the Government. A common problem faced by each department, bureau, or office involves the decision to lease telecommunications services or to provide the services by purchase of equipment and operation of the system. That is, a choice between the Government paying a monthly rental charge and the Government making a capital investment along with an implicit commitment to operate the telecommunications system. What is desired, of course, is a decision model (a procedure of making a choice) that:

(a) Can be applied by any Government agency involved in telecommunications,

(b) Can be used for any type of technical system,

(c) Ensures that the alternatives presented for decision are the best available,

(d) Leads to a decision in the national interest,

(e) Presents all significant aspects of the problem to the decision maker, and

(f) Is consistent with broader Government policy.

The development of a decision model meeting those criteria was accomplished by a team that included professional training and experience in telecommunications, systems analysis, economics, costing methodology, and government procedures. Planning Research was able to put together such an *ad hoc* team and apply it to this particular problem. Our project report provided the required decision model reflecting the full context of government decision making.

III. REASONS FOR SUPPORT OF SENATE BILLS 430 AND 467

It is natural for the Federal Government to take the lead in the application of systems analysis to civilian problems. It is natural for three reasons:

1. The size of the budgets of the Department of Defense, NASA, and the AEC and the rapid changes in technology associated with their fields have made it worthwhile for these organizations to sponsor research and development in systems analysis, budgeting, and management science techniques. This body of skill rests in the minds of Government employees and their contractors. Government support is a good idea where the value of a more effective performance is greater for the community as a whole than it is for the individual citizen.

2. Although something like five-sixths of the national economic activity is in the private enterprise sector, the private sector is primarily concerned with goods and services easily measurable by a unit such as the dollar and on which there is a market scale of product. The American community problems are concerned substantially with benefits that are diffuse and are not associated with a tangible product or easily measured in a quantifiable unit. The values of racial homogeneity, mental health, patriotism, and hopes are examples. Even things such as the quality of education or the value of clean air and water are extremely difficult to measure in terms that appeal to the private sector.

3. In many fields, the Federal Government, because of its large purchasing power, is an extremely influential factor. Although the amount of construction undertaken by GSA, the Corps of Engineers, and the Naval Facilities Engineering Command is small in proportion to total building in the country, the Federal Government is by far the largest single builder. Therefore, architectural specifications and Federal building codes are widely used in civilian practice. The Government, without expanding its financial share of activity, can wield great influence in the application of systems analysis to civilian problems.

In addition, making funds available to the states will greatly accelerate the application of systems analysis to problems at the state level. There has been some recognition and use of these new techniques to socio-economic problems in one or two states, but it is extremely small. This approach has been used successfully at the Federal level and the problems waiting to be solved at the state and local government levels are many.

I would like to put Planning Research Corporation on record as supporting Senate Bills 430 and 467. It is my opinion that the socio-economic problems toward which they are directed are most susceptible to solution by the techniques employed in systems analysis and that there is a sufficient, available pool of systems analysis capability in the growing for-profit sector of our economy to be applied to these problems.

PREPARED STATEMENT OF EUGENE B. WAGGONER, PRESIDENT, CONSULTING ENGINEERS COUNCIL

The members of Consulting Engineers Council/U.S.A. are both interested and encouraged by your study of proposals which may lead to the solutions of public problems through application of systems engineering techniques.

Consulting engineers more and more are utilizing systems analysis in the provision of services to communities and regional governments. Unfortunately, the cost of such comprehensive application of the engineer's skill to the many related factors which handicap urban and social development has frequently precluded total solution of existing problems.

As evidenced by your comments and legislation, the dimension of critical public and economic issues is staggering and increasingly complex. While Congress has adopted a host of "finger-in-the-dike" programs to aid local officials, problems relating to air and water pollution, urban transportation, housing, crime and similar concerns have steadfastly refused to yield to traditional solutions. New methods needed to be developed for attacking all these problems systematically and effectively.

Systems engineering has been successfully applied by consulting engineers to many complex projects. Even the relatively simple (to outsiders) task of designing communities, buildings and industrial plants requires, in a sense, application of systems analysis to insure orderly progression of design and construction without omitting elements of plumbing, drainage, foundation, grounding, traffic flow, ventilation, etc. On an even larger scale, consulting engineers have applied systems techniques to development of entire new cities and to major defense and space projects of the Federal Government.

We believe there is great potential for bringing the talents and expertise of private engineers to bear on the solution of civic and social problems of our nation and its sprawling urban areas. We are pleased to offer the services of this Council in clarifying this effort, as well as participating in its implementation.

Our members concur in the Congressional proposals, such as H.R. 20, which would establish a National Commission on Public Management, but we would strongly urge that at least one consulting engineer, experienced and qualified in the application of systems analysis to public problems, be included in the make-up of such a Commission.

At a time when the bright hope of Federal grant-in-aid programs has faded to the extent that Congressional review and coordination is sorely needed, and at a time when the Viet Nam crisis appears far from resolution, we believe that a Public Management Commission, consisting of representatives of various sectors of private business (including engineering) would, in itself, be a logical "systems approach" to developing programs for application of systems analysis to public problems.

[From Aerospace Management, Fall/Winter 1966]

THE SYSTEMS APPROACH: A UNIFIED CONCEPT OF PLANNING

(By P. G. Thome, R. G. Willard, GE–RSD [1])

"It is my experience that the hardest problems for the systems analyst are not those of analytic techniques . . . what distinguishes the useful and productive analyst is his abality to formulate (or design) the problem; to choose appropriate objectives; to define the relevant, important environments or situations in which to test the alternatives; to judge the reliability of his cost and other data, and not least his ingenuity in inventing new systems or alternatives to evaluate."

Charles J. Hitch—"Decisionmaking for Defense"

A disposition to economize available resources has historically been among the lesser attributes of man. Apparently, he has survived for millennia behaving like a profligate parasite, consuming resources at an increasing rate in order to fulfill his growing ambitions.

With the growth in the number, the physical dimensions and the complexity of his ambitious undertakings, has grown also his capacity to count, to measure, and to project his needs. And the development of these latent capacities has recently led to an apprehensive conclusion—that all resources at his disposal are finite, and that they must be managed through a new discipline founded on far-sighted techniques, rather than by the traditional measures of expediency that solved problems in a fragmentary way.

Projects of growing complexity and size, such as bridges, skyscrapers, ships and communication networks undoubtedly served to widen the vistas of visionary engineers for problem solving. But it took the pressures of the crash missile-development program in the last decade to identify the Systems Approach as a farsighted and total philosophy for defining and solving problems of a national scale and importance.

Most practitioners of the related disciplines associated with the Systems Approach would be the first to warn that this approach is not a magic cure-all; they would hardly gree completely on its definition, nor would they agree on whether it should be identified as Systems Engineering Systems Analysis, or Systems Approach. In fact, in most cases these terms are used synonymously.

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[1] This article was prepared jointly by Pitt G. Thome, Manager, Planetary Entry Systems, and Robert G. Willard, Systems Engineer, Advanced Systems Operation, while both authors were in the Systems and Technologies Section, Re-Entry Systems Department of General Electric. Presently Mr. Thome is Program Manager, Advanced Programs and Technology, at NASA.

The authors of this article contend that "Systems Approach" is a more descriptive and appropriate term—by its broader meaning—than Systems Analysis or Systems Engineering. Reason being that "engineering" has a hardware connotation, and "analysis" implies the separation into parts or elements, of something which is already in existence. The chief attribute of the Systems Approach is that it can be applied with equal effectiveness to problems of a material nature—with well defined boundaries—as to the very process of delineating the boundaries of a dilemma so it can be focused sharply into a problem and then be solved.

ORDERLY WAY OF APPRAISAL

The Systems Approach is an orderly way of appraising a human need of a complex nature, in a "let's stand back and look at this situation from all its angles" frame of mind, asking one's self:

How many distinguishable elements are there to this seeming problem?
What cause-and-effect relationships exist among these elements?
What functions need to be performed in each case?
What trade-offs may be required among resources, once they are defined?

We said above that the Systems Approach is suitable for assessing the challenges of a broad scale or of national significance. In the aerospace arena, challenges of this magnitude as a rule are programs characterized by the following orders of difficulty:

A complex goal (involving a major system composed of hardware, computer programs, facilities, personnel and data).

A constantly changing environment (which affects objectives, constraints and criteria).

Limited resources for advanced development (money, manpower, facilities and time).

For programs of this nature, the application of the Systems Approach early in the conceptual phase helps to reduce the chances for oversight, or the occurrence of so called "appraisal gaps." And this is achieved by using a structured technique to continuously identify and assess the impact of changing objectives, constraints, and design criteria on required resources: technologies, personnel and facilities.

GENERAL GUIDELINE

If it were possible to prescribe some basic precepts to be used in developing total system requirements, these would be: (1) Start at the highest and most general echelon of cognizance and authority to determine the boundaries of the overall system; (2) Proceed to define the system, in stages of increasing detail, translating functional requirements into hardware requirements; (3) Don't prejudge solutions! Any solutions in mind should serve as guides, rather than points of departure, in the planning process.

To understand what the logic of the Systems Approach is, it is equally important to understand what it is not. In a sense, the logic of the Systems Approach is the converse of the logic used in inductive reasoning. The inductive approach (Fig. 1) begins with particulars, i.e. the collection of data used for synthesizing a theory or plan. In this approach, the objectives, or the general statement of the problem serves mostly as a constraint—to limit the introduction of data relative to the problem. The inductive approach is sometimes used by functional organizations to assemble an advanced technology development plan. In such cases, proposed development tasks and programs are submitted separately by each of the technology areas, then selected and integrated into an overall program. As a result, the inductive approach often leads to *solutions looking for problems to solve*, instead of focusing on the utilization of development resources.

LOGIC OF SYSTEMS APPROACH

Briefly stated, the logic of the Systems Approach is "deductive/inductive," and here's why. The thinking path provided by this approach is in the form of a closed loop that has distinct stages for timely inputs and continuous feedback. As such, thinking evolves in cyclic fashion, as it progresses from general objectives to plans (deductive process), then back to refining objectives and to detailing plans further.

Up to this point in this article we have discussed the basic philosophy of the Systems Approach; to discuss the stages of analysis involved in this approach we need the assistance of successive diagrams to develop and expand our concept in progressive stages.

In its most basic form, the concept of the Systems Approach is presented in the lower half of Fig. 1, showing that "objectives" are used as a point of departure. Then the objectives are analyzed, by successive stages, into detailed requirements and approaches. In each stage, additional new data is introduced (inductive process) to support the analysis. Next, selection criteria are determined, compatible with the original objectives, and are applied to choose the approaches; then the selections are synthesized (inductive process) into an advanced development plan or system design.

Importance of timing

The timing of contributions from specialists is a very important aspect of the Systems Approach. As considerations progress from the general objectives toward detailed requirements, the knowledge and judgment of experts in various technical disciplines are brought into play. But a significant point is that preliminary requirements must first evolve to a stage of maturity where needs can be defined in terms of functions. If detailed knowledge were tapped too early in the process, there would be a danger of formulating advanced development plans that are generated primarily by preconceived solutions.

Another cardinal rule to follow in implementing the Systems Approach is to practice disciplined documentation from start to finish. Thoughts are volatile, memories crowed, and organizations fluid. For these reasons it is vital to record the course of development, the approaches which have been considered, and the reasons for selections and rejections—a good plan must have the strength of a good argument.

We can gain further insight to the Systems Approach by viewing it as a *cycle* which has an expanding phase (the analysis) and a contracting phase (the synthesis). During the analysis the objectives are resolved into their constituent requirements and possible approaches; during the synthesis the approaches are weighed and selected through a trade-off study, then integrated into a system model or development program. This cycle *is repeated* at successive decision-making echelons of system planning or design, so that the output of each cycle is used as an input for the succeeding one.

To get closer to the structure of the Systems Approach, let's refer to Fig. 2, which highlights the four principal stages or steps involved: translation, analysis, trade-off, and synthesis. The translation, or initial formulation of the problem is an important step since it sets the course of all the work that will follow. Translation includes the interpretation of objectives and all recognized constraints on the problem solution. At this step in the cycle, the selection criteria are also determined. These criteria are later used in the trade-off study. Some categories of constraints, such as timing and policy, are also used as selection criteria. The difference between these two uses is that constraints are generally applied as absolute limitations, whereas selection criteria are applied later in the cycle to determine the relative merit of possible approaches. During the cycle a number of feedbacks may be required. as shown in the diagram, to improve and re-evaluate the output.

DECISION-MAKING CYCLES

One of the reasons why the Systems Approach is effective is that it is characterized by structural consistency. That is, the cycle described above recurs at each echelon of decision making—from the policy definition level down to the level of implementation, as schematized in Fig. 3. We see here that at each echelon the possible approaches are evaluated against criteria, approaches are selected, and requirements determined. These decisions become the inputs to the following cycle. Thus, with each successive cycle the definition becomes more detailed. Incidentally, the reverse of the process—starting at the bottom of the diagram and proceeding upward—would represent an inductive approach to the planning process.

At this point then, not to lose sight of the very purpose of the Systems Approach for the thickening forest of chartwork, we should restate that we are following a structured approach for generating advanced development plans.

For all practical purposes, the advanced planning process begins with the Mission Definition Cycle, after broad objectives have been stated based on policy definition. The advanced planning procedure can best be followed through a matrixed sequence depicted in Fig. 4, where cycles are identified along the top, and the steps within each cycle are shown in the left column.

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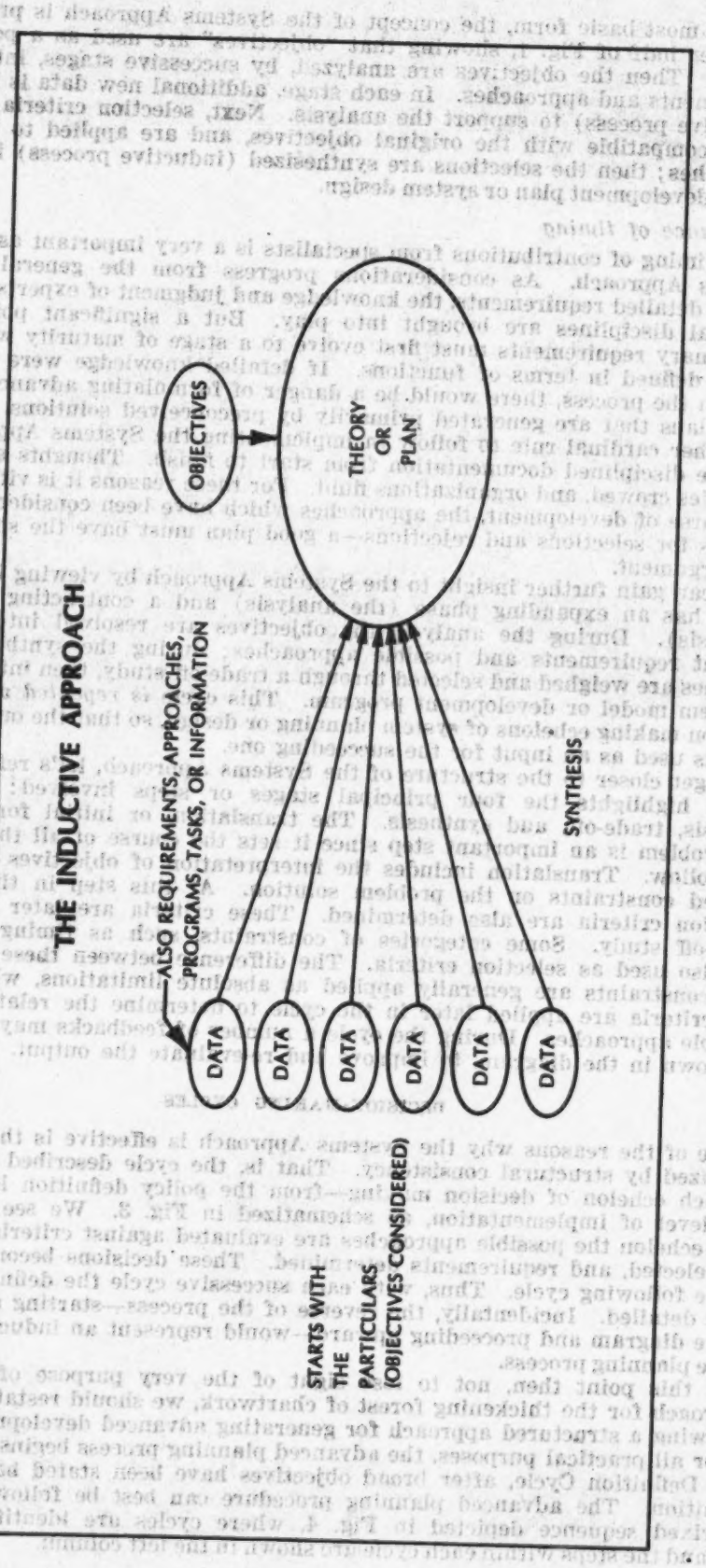
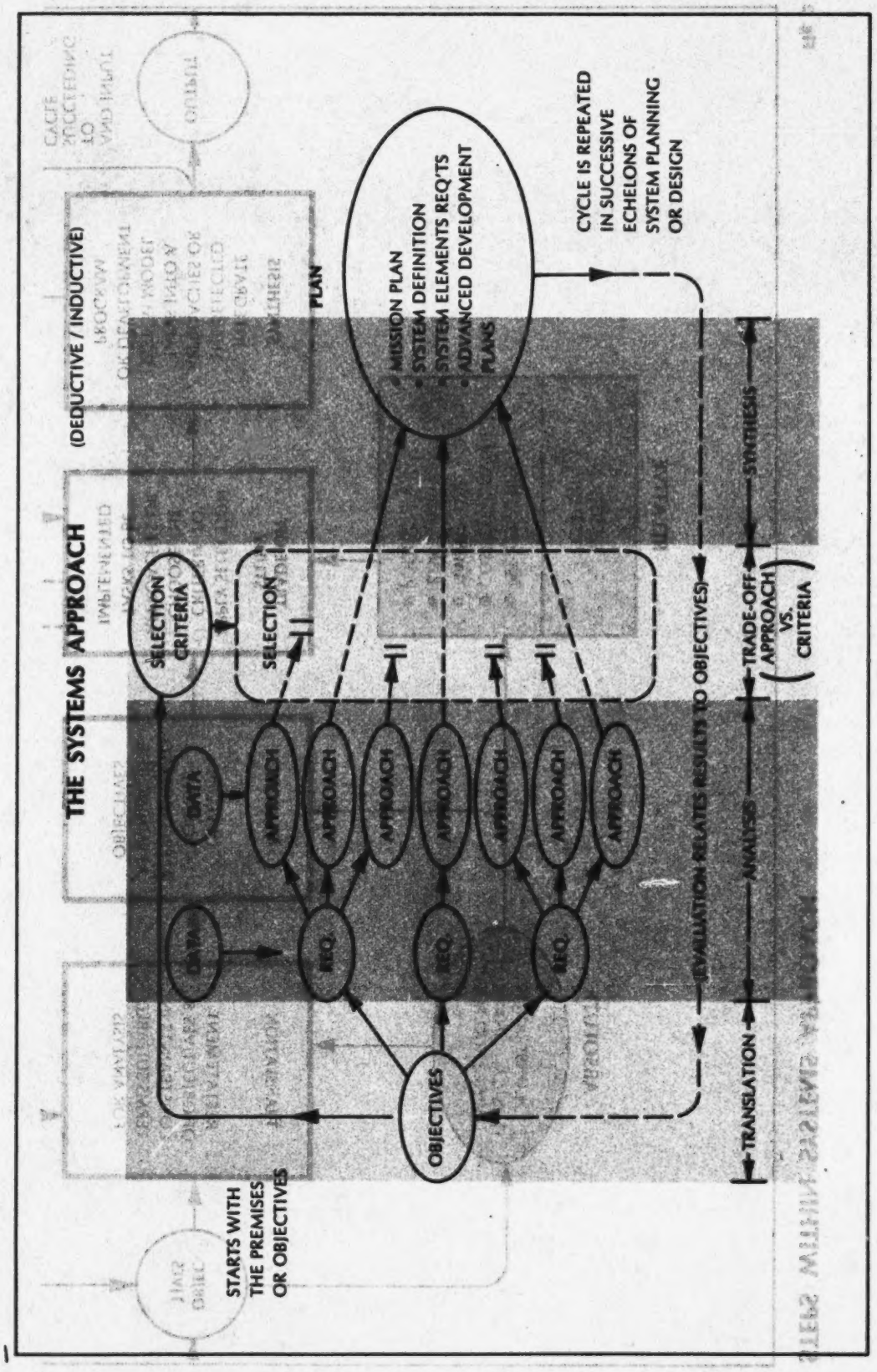
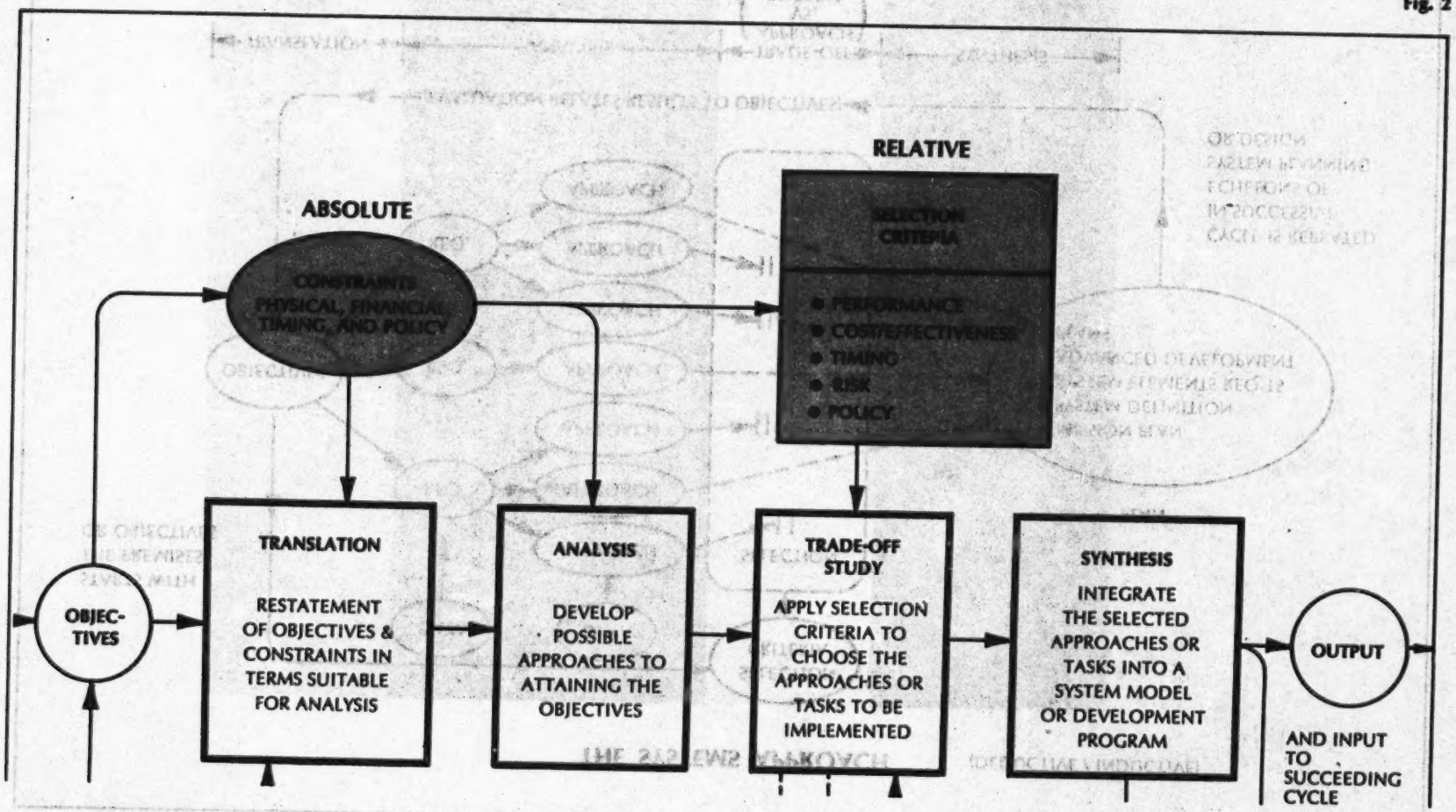
Fig. 1

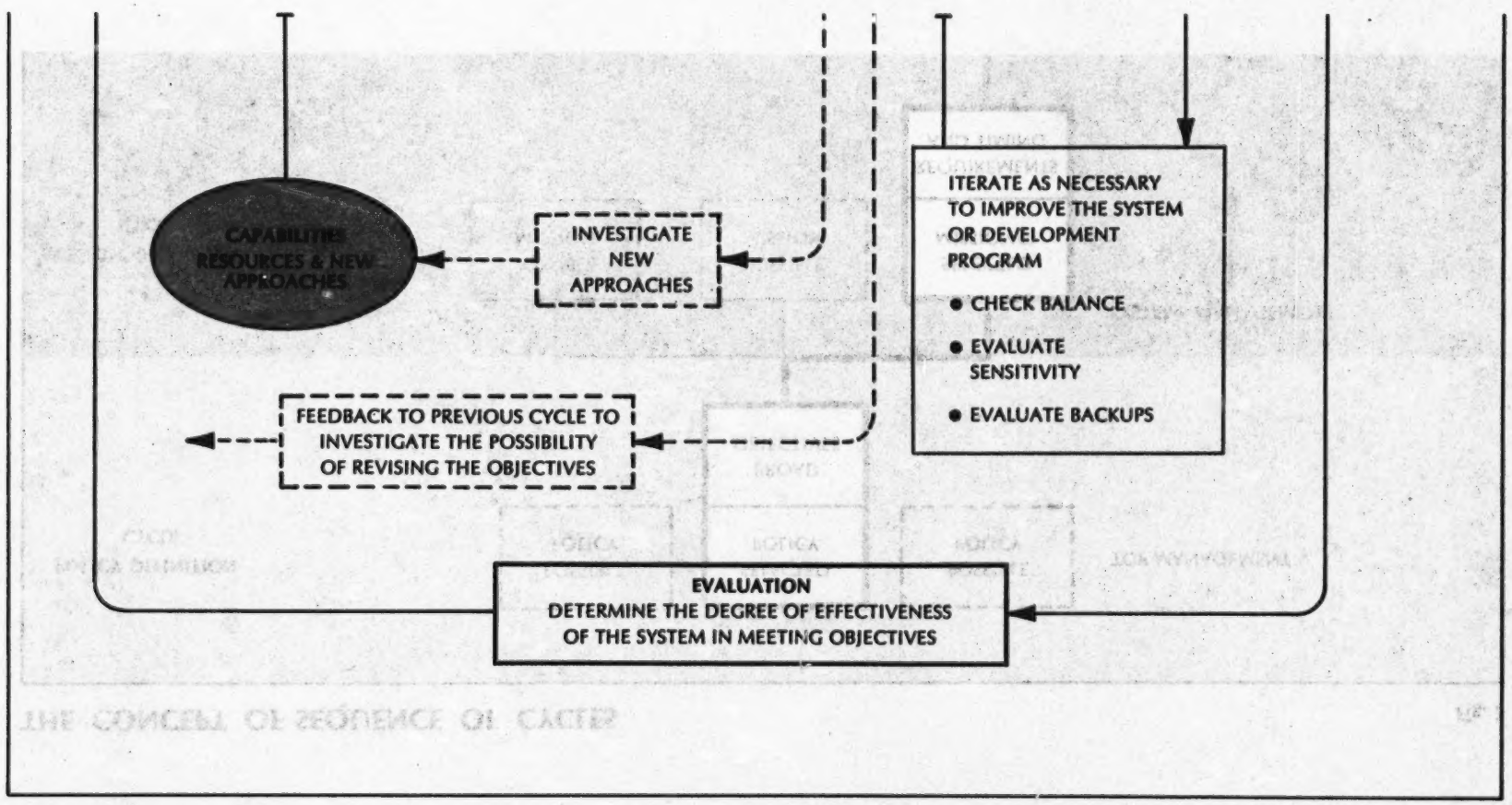

PLANNING APPROACHES
THE INDUCTIVE APPROACH
ALSO REQUIREMENTS, APPROACHES, PROGRAMS, TASKS, OR INFORMATION
STARTS WITH THE PARTICULARS (OBJECTIVES CONSIDERED)
SYNTHESIS
OBJECTIVES
THEORY OR PLAN
DATA
DATA
DATA
DATA
DATA
DATA


THE SYSTEMS APPROACH
(DEDUCTIVE / INDUCTIVE)
PLAN
SELECTION CRITERIA
SELECTION
DATA
APPROACH
REQ.
OBJECTIVES
STARTS WITH THE PREMISES OR OBJECTIVES
MISSION PLAN
SYSTEM DEFINITION
SYSTEM ELEMENTS REQ'TS
ADVANCED DEVELOPMENT PLANS
CYCLE IS REPEATED IN SUCCESSIVE ECHELONS OF SYSTEM PLANNING OR DESIGN
EVALUATION RELATES RESULTS TO OBJECTIVES
TRADE-OFF (APPROACH) VS. CRITERIA
SYNTHESIS
TRANSLATION
ANALYSIS

STEPS WITHIN SYSTEMS APPROACH

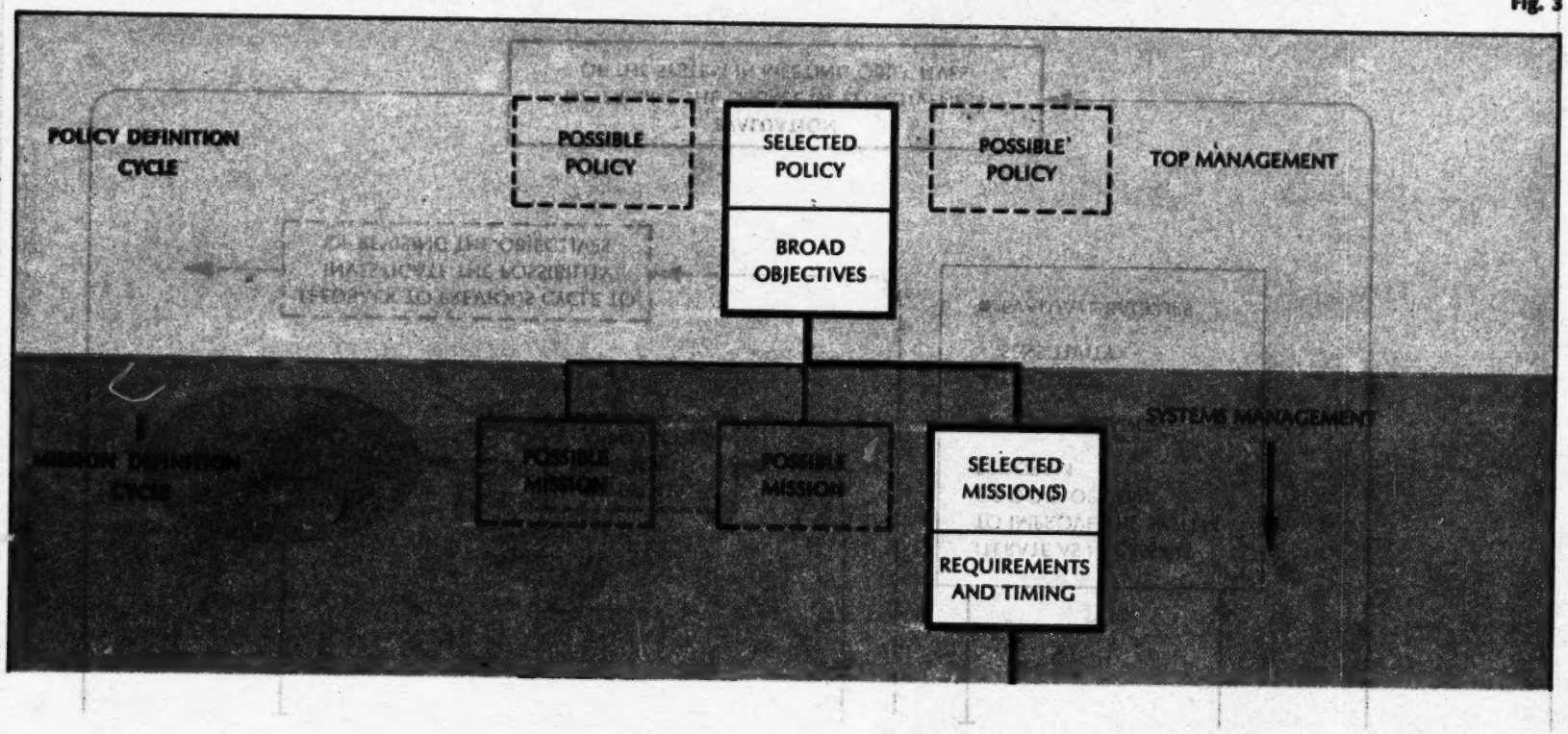
Fig. 2

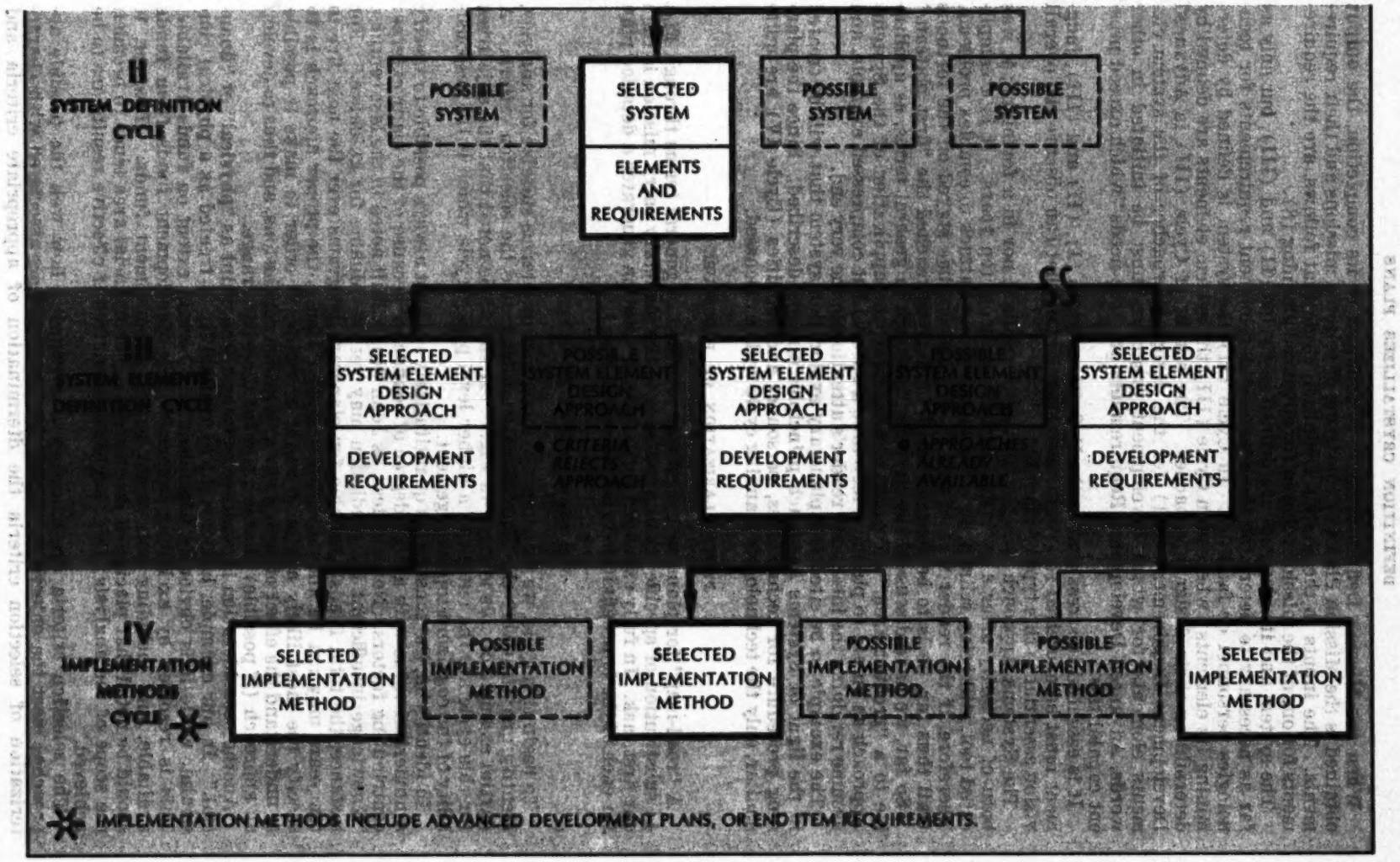



CAPABILITIES RESOURCES & NEW APPROACHES
INVESTIGATE NEW APPROACHES
ITERATE AS NECESSARY TO IMPROVE THE SYSTEM OR DEVELOPMENT PROGRAM
• CHECK BALANCE
• EVALUATE SENSITIVITY
• EVALUATE BACKUPS
FEEDBACK TO PREVIOUS CYCLE TO INVESTIGATE THE POSSIBILITY OF REVISING THE OBJECTIVES
EVALUATION
DETERMINE THE DEGREE OF EFFECTIVENESS OF THE SYSTEM IN MEETING OBJECTIVES

THE CONCEPT OF SEQUENCE OF CYCLES

Fig. 3




II
SYSTEM DEFINITION CYCLE
POSSIBLE SYSTEM
SELECTED SYSTEM
ELEMENTS AND REQUIREMENTS
POSSIBLE SYSTEM
POSSIBLE SYSTEM
III
SYSTEM ELEMENTS DEFINITION CYCLE
SELECTED SYSTEM ELEMENT DESIGN APPROACH
DEVELOPMENT REQUIREMENTS
POSSIBLE SYSTEM ELEMENT DESIGN APPROACH
* CRITERIA SELECTS APPROACH
SELECTED SYSTEM ELEMENT DESIGN APPROACH
DEVELOPMENT REQUIREMENTS
POSSIBLE SYSTEM ELEMENT DESIGN APPROACH
* APPROACHES ALREADY AVAILABLE
SELECTED SYSTEM ELEMENT DESIGN APPROACH
DEVELOPMENT REQUIREMENTS
IV
IMPLEMENTATION METHODS CYCLE *
SELECTED IMPLEMENTATION METHOD
POSSIBLE IMPLEMENTATION METHOD
SELECTED IMPLEMENTATION METHOD
POSSIBLE IMPLEMENTATION METHOD
POSSIBLE IMPLEMENTATION METHOD
SELECTED IMPLEMENTATION METHOD
* IMPLEMENTATION METHODS INCLUDE ADVANCED DEVELOPMENT PLANS, OR END ITEM REQUIREMENTS.

DEFINITION CRYSTALLIZES PLANS

When the Mission Definition Cycle is followed to its completion, the output obtained is the Mission Plan (7) consisting of selected missions and their requirements. The inputs to the System Definition Cycle that follows, are the requirements for one of the missions chosen for advanced planning (8).

The system and its elements are defined in Cycles (II) and (III), but only as far as necessary to determine the advanced development requirements for technologies personnel or facilities. In Cycle (II) the system is defined by determining its elements; whereas in Cycle (III) the system elements are defined by determining their design approaches. The output of Cycle (III) is Advanced Development Requirements (21) for the design approaches of the system elements elements for which development programs must be initiated in other words, Advanced Development Requirements are "the needs" which exceed present capabilities.

It is essential to stress that in the Definition Cycles (I), (II) and (III), judgment must be exercised to avoid unnecessary detail that can obscure the overall vision essential to this type of planning.

The Systems Approach was not conjured overnight nor in a fortnight; it was born of necessity after a gestation period of almost ten years. It is a complicated tool, still being refined, and is used as a plan of attack to complex problems. Therefore, if the reader who is new to this concept has stayed on the tortuous trail thus far, he is to be congratulated for having reached the "first plateau."

So far, we have discussed the Systems Approach in general terms, as applicable to a "product area." To better understand the application of the Systems Approach as an aid to planning let's take a specific but compressed example, and assume retaining the interested reader's attention to the very end.

The example to be cited is a planetary exploration system that will be treated in the light of Systems Approach principles already described. Since the planning procedure for technologies, personnel and facilities (Cycle IV) are quite similar, only the technologies planning cycle will be discussed.

PARTICULARIZATION OF PROCEDURE

A "road-map" for planning cycles was provided in general terms through Fig. 4; substitution of specific terms applicable to the planetary entry mission is then our first task. In fully-expanded form this substitution generates a detailed plan for each of the four definition cycles shown in Fig. 4.

MISSION DEFINITION CYCLE

To begin this cycle, we translate the objectives into terms suitable for analysis, identify quantitatively the constraints, and determine the selection criteria. A partial example of this is given in Fig. 5. It should be noted that the objectives for this cycle are the output of a higher level policy cycle which is the responsibility of the cognizant top management.

In identifying the constraints quantitatively it is not always possible to specify a numerical value with a high degree of confidence because of the many external contributing factors. Nevertheless, as John Stuart Mill noted in the last century, "Knowledge insufficient for prediction may yet be valuable for guidance." For instance, the total funds available for planetary programs over the next five to ten years may not be known with certainty. Hence, the proper approach is to specify the most likely available range of funds, in order to make it possible to understand the effect of such a variable on the conclusions, and thus to develop an approach (if possible) that is valid for the entire range.

Another consideration is whether to treat a constraint as "physical" or "financial." In our example, launch vehicle availability is treated as a physical constraint, while it is obviously dependent to a certain extent on funds available. This is resolved by excluding launch vehicle development funds from funds available, and including only flight article procurement funds. However, it should be noted that placing of constraints in the financial area tends to broaden the scope of the analysis; this should be minimized if effective results are to be achieved.

The selection criteria are a means of measuring how well the possible approaches meet the objectives. There are two problems associated with characterization of selection criteria the dtermination of appropriate criteria and

the establishment of their relative importance. For instance, criteria are derived from the objectives and constraints by asking such questions as: How well does the proposed set of missions match the scientific objectives? Is the emphasis on the proper place? Since the scientific objectives cover a wide range—extending from the exploration of Mars to exploration of comets and major planets—is the proposed set of missions broad enough and yet of sufficient depth to really advance our state of knowledge of the solar system? Are they consistent with NASA objectives, e.g., to maintain program continuity?

The establishment of the relative importance of the criteria can only be made after a detailed study of the objectives and constraints. One example of this judgment is given in Fig. 5.

Here the analysis step involves development of possible approaches, within the constraints, in attaining the objectives. The procedure is to analyze the possible approaches in successive stages of increasing detail. For instance, in Fig. 5, the classes of possible planetary programs are first identified, then the classes of spacecraft which fit within each of these programs are developed. The classes of possible spacecraft must be identified to the extent that they can be compared with the overall objectives and determination made as to whether or not they are within the constraints. Therefore, the definition must include such items as weight, scientific capability, cost, and manpower requirements. It is then possible to combine these into any number of credible combinations. For the planetary exploration systems, for example, a total of 24 combinations could be identified. For brevity, only three combinations have been included in Fig. 5.

Having identified the possible mission combinations. there must be evaluated in terms of how well they meet the selection criteria. Every mission combination must be compared with each of the others to assess relative values. This is repeated for each of the criteria and a total evaluation is obtained by combining the results for each.

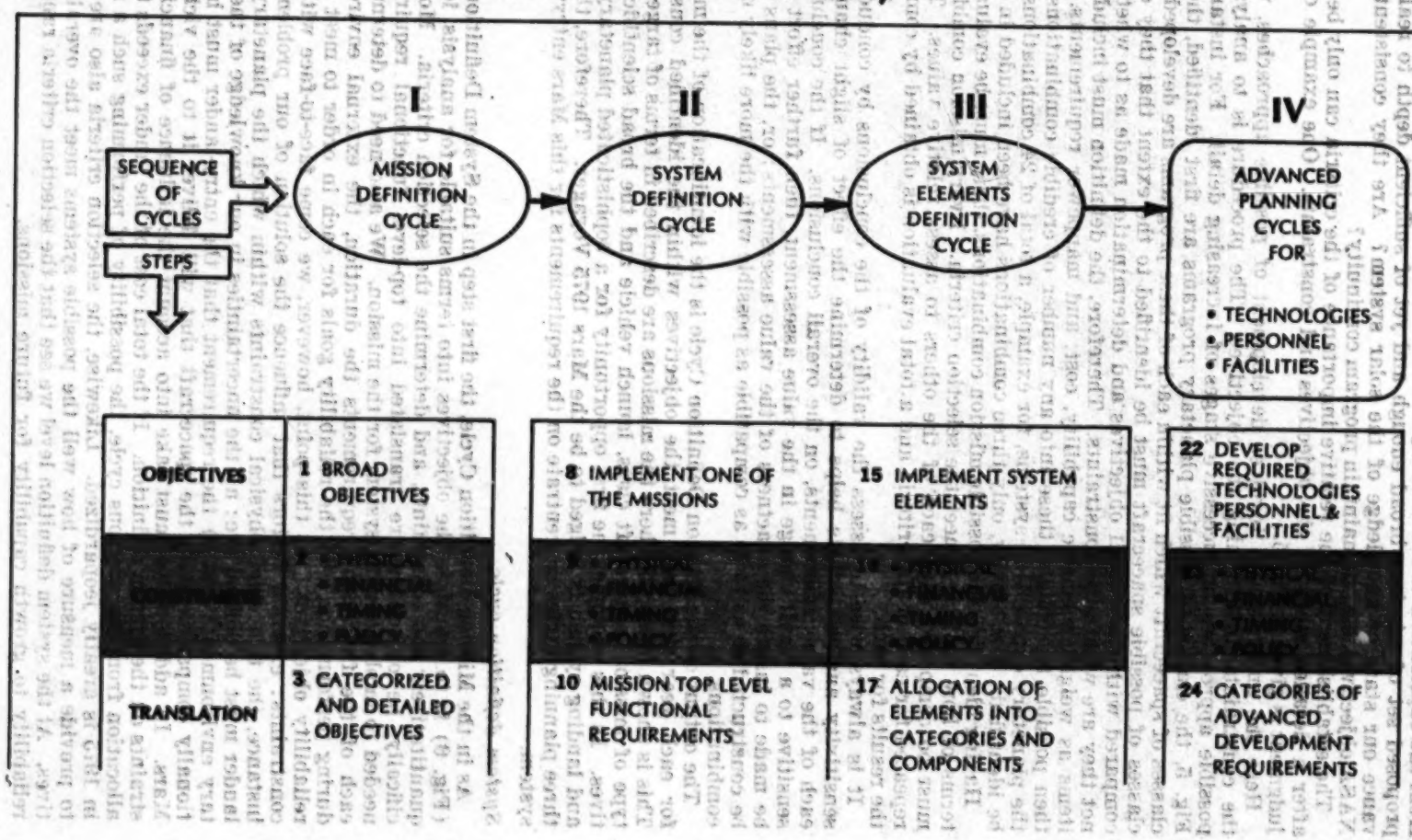
It is always wise to assess the validity of the conclusions by conducting a sensitivity analysis. This helps to determine the effect of slight changes in each of the value assessments, on the overall conclusions. If the conclusion is sensitive to a small change in the value assessment, then further effort should be made to insure the exactness of the value assessments; or, the plans should be constructed so as to be as compatible as possible with the more likely mission combinations.

The output of the Mission Definition Cycle is the identification of the missions for each year that best meet the objectives within the identified constrains. This is shown in Fig. 5 where the missions are described in terms of target body, type of mission, spacecraft class, launch vehicle and the broad scientific objectives. In this example, the first opportunity for a sophisticated planetary entry and landing system is judged to be the Mars 1975 Voyager. Therefore, the next three planning cycles concentrate on the requirements for this Mars entry lander system.

System definition cycle

As in the Mission Definition Cycle, the first step in the System Definition Cycle (Fig. 6) is to translate the objectives into terms suitable for analysis, identify quantitatively the constraints, and determine the selection criteria. More specifically, he objectives are translated into top-level functional requirements needed to implement the system for the mission. We also need to determine for each of the functional requirements the duration, the external environment during performance, and the reliability goals for each in order to meet overall reliability objectives. At this point, however, we come face-to-face with some constraints: external factors that influence the solution of our problem. For instance, the two chief physical constraints within which the planetary entry lander must be defined are: a) the uncertainties in our knowledge of the planetary environment; and b) the requirement that the entry-lander must be functionally compatible with the spacecraft that will deliver it to the vicinity of Mars. In addition, we must take into account the influence of financial constraints on the system definition. If the total cost of the lander exceeds the cost allocation from the previous cycle, the possibility of performing such a mission in 1975 is greatly jeopardized. Likewise, the selection criteria also are chosen to provide a measure of how well the possible systems meet the overall objectives. At the system definition level we see that the selection criteria range from reliability to growth capability for future missions.

ADVANCED PLANNING PROCEDURE (FOR A PRODUCT AREA)



ANALYSIS	**4 POSSIBLE MISSIONS AND APPROACHES WITH REQUIREMENTS**	**11 POSSIBLE DETAILED FUNCTIONS; SYSTEM ELEMENTS AND THEIR PERFORMANCE REQUIREMENTS**	**18 POSSIBLE DESIGN APPROACHES FOR THE COMPONENTS AND THEIR DESIGN REQUIREMENTS**	**25 POSSIBLE DEVELOPMENT TASKS, SCHEDULES, DECISION POINTS AND FUNDING APPROACHES**
TRADE-OFF & SYNTHESIS	**6 SELECTED MISSIONS AND THEIR BROAD REQUIREMENTS**	**13 SELECTED SYSTEM ELEMENTS & THEIR PERFORMANCE REQUIREMENTS**	**20 SELECTED DESIGN APPROACHES**	**27 SELECTED DEVELOPMENT TASKS**
CYCLE OUTPUT	**7 MISSION PLAN** • MISSIONS • REQUIREMENTS • TIMING	**14 SYSTEM DEFINITION SYSTEM ELEMENTS AND THEIR PERFORMANCE REQUIREMENTS**	**21 ADVANCED DEVELOPMENT REQUIREMENTS** • DESIGN APPROACHES • DEVELOPMENT REQUIREMENTS • TIMING	**28 ADVANCED DEVELOPMENT PLANS** • TASKS • SCHEDULE • DECISION POINTS • FUNDING • APPROACH

MISSION DEFINITION CYCLE—PLANETARY EXPLORATION SYSTEMS PRODUCT AREA—IMPLEMENTATION Fig. 5

OBJECTIVES	1) SATISFY SCIENTIFIC INTEREST 2) ENHANCE NATIONAL PRESTIGE
CONSTRAINTS	PHYSICAL: • EARTH BASED OBSERVATION CAPABILITIES • LAUNCH VEHICLE AVAILABILITY FINANCIAL: FUNDS AVAILABLE TIMING: LAUNCH WINDOWS OCCURENCE POLICY: • NASA CENTER OBJECTIVES • NASA MANPOWER LIMITATIONS
TRANSLATION	DETAILED OBJECTIVES IN USABLE FORM OF THE: 1) SCIENTIFIC INTEREST IN EACH OF THE PLANETS & PRIORITIES 2) IMPORTANT FACTORS THAT ENHANCE NATIONAL PRESTIGE

IMPLEMENTATION

TRANSLATION	EXPLORATION OBJECTS (IN ORDER OF PRIORITY)	LIFE CHARACTER-IZATION	SOLAR SYSTEM EVOLUTION	PRIME UNKNOWN
ELUCIDATION OF FUNDAMENTAL COSMOLOGICAL AND BIOLOGICAL QUESTIONS • ORIGIN AND EVOLUTION OF LIFE • ORIGIN AND EVOLUTION OF SOLAR SYSTEM	MARS	X	X	• PRESENCES OF LIFE AND CHARACTERISTICS • SURFACE TERRAIN AND COMPOSITION • SUBSURFACE AND CORE • DEFINITION OF ATMOSPHERE AND WEATHER
	VENUS	X	X	• PRESENCES OF LIFE AND CHARACTERISTICS • DEFINITION OF ATMOSPHERE, CLOUDS, & WEATHER • SURFACE COMPOSITION AND TERRAIN • SUBSURFACE AND CORE
	MAJOR PLANETS		X	• RADIATION BELTS • MAGNETIC FIELDS • NATURE OF ATMOSPHERE • NATURE OF SURFACE AND CORE
	COMETS AND ASTEROIDS		X	• COMPOSITION • FIELDS • ORIGIN
	MERCURY		X	• COMPOSITION • ATMOSPHERE

ANALYSIS

APPLICATION OF CONSTRAINTS TO DETERMINE POSSIBLE:

1) CLASSES OF PLANETARY PROGRAMS IN TERMS OF TARGET PLANET, LAUNCH VEHICLE & MISSION LIFE

2) CLASSES OF SPACECRAFT IN TERMS OF MISSION MODE (FLYBY, ORBIT OR LAND AND SIZE FOR EACH OF THE PLANETARY PROGRAMS)

3) MISSION COMBINATIONS IN TERMS OF CLASS OF PLANETARY PROGRAM, CLASS OF SPACECRAFT & LAUNCH OPPORTUNITY

IMPLEMENTATION

ANALYSIS

1 CLASSES OF PLANETARY PROGRAMS

	TARGET OBJECT	LAUNCH VEHICLE	MISSION LIFE
MARINER	MARS VENUS COMETS ASTEROIDS MERCURY	ATLAS/ CENTAUR	9 MONTHS
VOYAGER	MARS VENUS	SATURN V	9 MONTHS TRANSIT 6 MONTHS AT PLANET
ADVANCED PLANETARY PROBE (APP)	MAJOR PLANETS	ATLAS/ CENTAUR/ HEKS	~ 2 YRS
ADVANCED VOYAGER	MAJOR PLANETS	SATURN IB/ CENTAUR/ HEKS	~ 2 YRS

2 CLASSES OF SPACECRAFT

	SPACECRAFT /SCIENCE	ENTRY VEHICLE SCIENCE	COST
	(LBS.)	(LBS.)	
MARINER	600–60	– –	~
	800–90	– –	~
	1000–60	100–16	~
	1000–60	300–50	~
	1000–60	500–80	~
VOYAGER	3100–400	100–16	~
	3100–400	3000–130	~
	3100–400	10,000–1000	~
ADVANCED PLANETARY PROBE (APP)	700–45	– –	~
ADVANCED VOYAGER	2000–200	– –	~

3 MISSION COMBINATIONS

	#1	#2	#3
1967	VENUS FLYBY	VENUS FLYBY	
1968			
1969	MARS FLYBY	MARS FLYBY	
1970			
1971		MARS FLYBY 100 LBS CAP	
1972	VENUS/MERCURY FLYBY 300 LBS CAP		
1973	MARS (S-S) ORBITER	MARS (S-S) ORB'R VENUS/MERCURY 300 LBS CAP	
1974	PRECURSOR (ONE PER YEAR)	PRECURSOR (ONE PER YEAR)	

SELECTION CRITERIA	PERFORMANCE:	• SCIENTIFIC EMPHASIS OF PROGRAMS • BREADTH OF PROGRAMS • FREQUENCY OF PROGRAMS • INCREASING RETURN • PROGRAM CONTINUITY
	COST EFFECTIVENESS:	• MIX OF PLANETARY PROGRAM CLASSES • NASA MANPOWER UTILIZATION
	TIMING: RISK: POLICY:	ORDER OF SCIENTIFIC RETURN SOUND PROGRAM EVOLUTION CONSISTENCY WITH NASA OBJECTIVES
TRADE-OFF & SYNTHESIS	APPLY SELECTION CRITERIA TO CHOOSE MOST DESIRABLE COMBINATION OF MISSIONS	

IMPLEMENTATION

TRADE-OFF

SELECTION CRITERIA →

		SCIENTIFIC EMPHASIS ON PROGRAMS	BREADTH OF PROGRAMS	FREQUENCY OF PROGRAMS	INCREASING RETURN	PROGRAM CONTINUITY	MIX OF PROGRAM CLASS	NASA MANPOWER UTILIZATION	ORDER OF SCIENTIFIC RETURN	SOUND PROGRAM EVOLUTION	CONSISTENCY WITH NASA OBJECTIVES	TOTAL RATING
MAXIMUM RATINGS →		20	15	15	15	15	15	10	20	20	15	
MISSION COMBINATIONS	#1	17	14	15	15	12	12	9	15	12	12	133
	#2	18	14	19	15	14	13	10	20	20	14	157
	#3	20	14	17	15	10	15	8	17	18	10	144

OUTPUT

MOST DESIRABLE PLANETARY MISSIONS FOR EACH YEAR IN TERMS OF:

1) TARGET PLANET

2) CLASS OF SPACECRAFT

3) LAUNCH VEHICLE

4) BROAD SCIENTIFIC OBJECTIVES

IMPLEMENTATION

OUTPUT

	1967	1969	1971	1972	1973	1974	1975
TARGET BODY	VENUS	MARS	MARS	VENUS	MARS	JUPITER	MARS
TYPE OF MISSION	FLYBY	FLYBY	FLYBY & ENTER	FLYBY & ENTER	ORBIT & ENTER	FLYBY	ORBIT & LAND
SPACECRAFT CLASS	MARINER	MARINER	MARINER	MARINER	VOYAGER	ADV. PLANETARY PROBE	VOYAGER
LAUNCH VEHICLE	ATLAS/AGENA	ATLAS/CENTAUR	ATLAS/CENTAUR	ATLAS/CENTAUR	SATURN V	ATLAS/CENTAUR/ HEKS	SATURN V
BROAD SCIENTIFIC OBJECTIVES	• ATMOSPHERE CHARACTERISTICS • PLANET ENVIRONMENT	• HIGH RESOLUTION PICTURES • ATMOSPHERIC CHARACTERISTICS • PLANET ENVIRONMENT	• ATMOSPHERE DEFINITION • HIGH RESOLUTION PICTURES • PLANET ENVIRONMENT	• ATMOSPHERE DEFINITION • SURFACE HARDNESS • NATURE OF CLOUDS • PLANET ENVIRONMENT	• TV MAP • SURFACE TEMP. • ATMOSPHERIC DEFINITION • PLANET ENVIRONMENT • KEY SURFACE ELEMENTS	• RADIATION BELTS • MAGNETIC FIELD • ATMOSPHERIC CHARACTERISTICS • ASTEROID BELT ENVIRONMENT	• TV MAP • SURFACE PICTURES (TV) • SURFACE COMP. • TIME VARIATION OF ATMOSPHERE • PLANET ENVIRONMENT

SYSTEM DEFINITION CYCLE (PLANETARY ENTRY PRODUCT AREA)—IMPLEMENTATION

Fig. 6

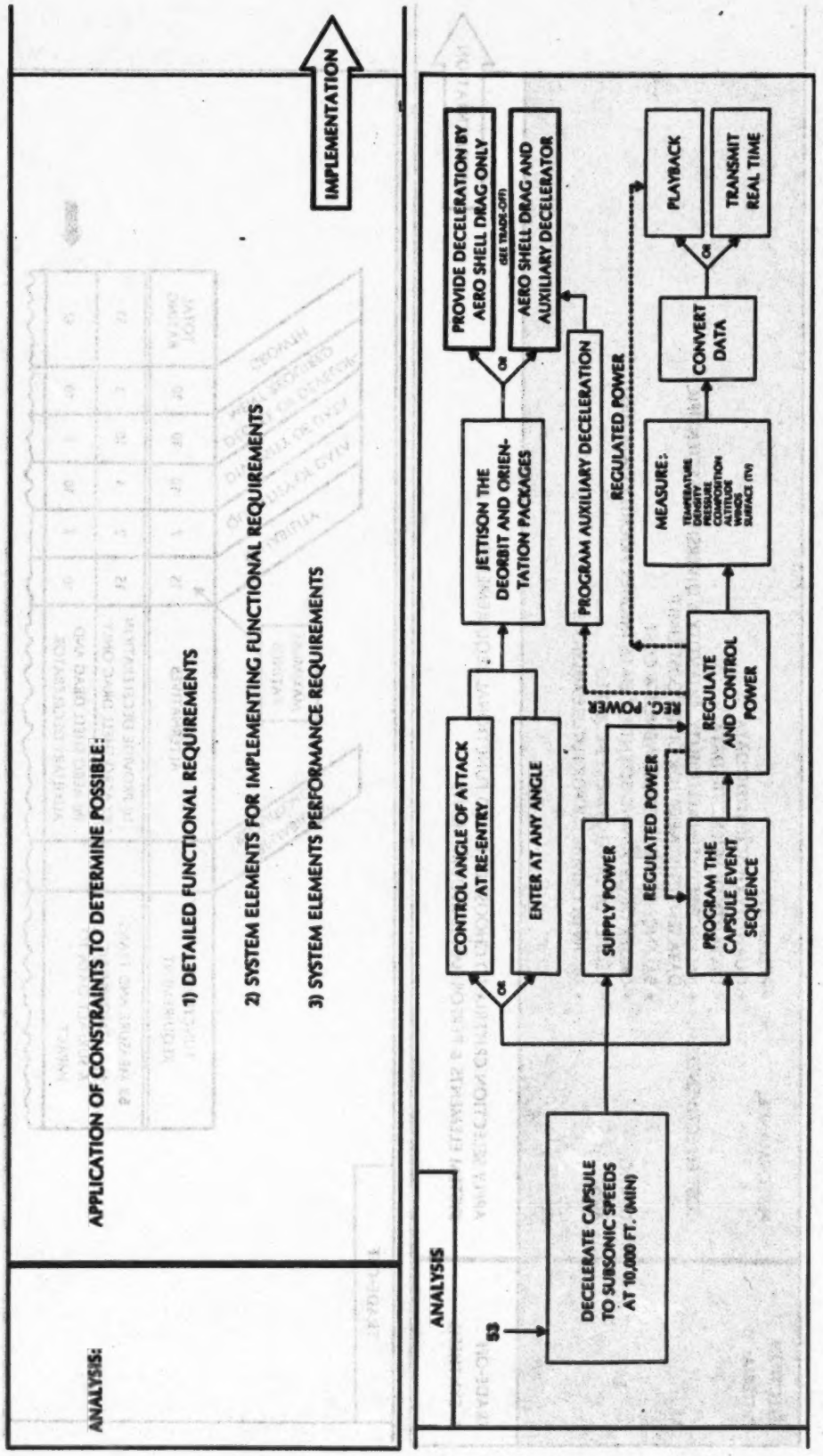
OBJECTIVE:	IMPLEMENT SYSTEM FOR MISSION DEFINED IN TERMS OF: 1) TARGET PLANET (MARS) 3) CLASS OF SPACECRAFT (INCLUDING COST) (3000 LB ENTRY-LANDER) 2) LAUNCH OPPORTUNITY (1975) 4) LAUNCH VEHICLE (SATURN V) 5) BROAD SCIENTIFIC OBJECTIVES
CONSTRAINTS:	PHYSICAL: • ENVIRONMENTAL & DYNAMICAL KNOWLEDGE OF PLANETS • FUNCTIONAL COMPATIBILITY WITH SPACECRAFT FINANCIAL: • REMAIN WITHIN PROGRAM COST LIMIT TIMING: • TWO SPACECRAFT TO BE READY FOR LAUNCH WITHIN THE LAUNCH WINDOW POLICY: • PLANETS ARE NOT TO BE CONTAMINATED BY EARTH ORGANISMS • UNTIL YEAR 2000
TRANSLATION:	ESTABLISH TOP LEVEL FUNCTIONAL REQUIREMENTS WITH— 1) DURATION 2) EXTERNAL ENVIRONMENTS AND 3) RELIABILITY GOAL

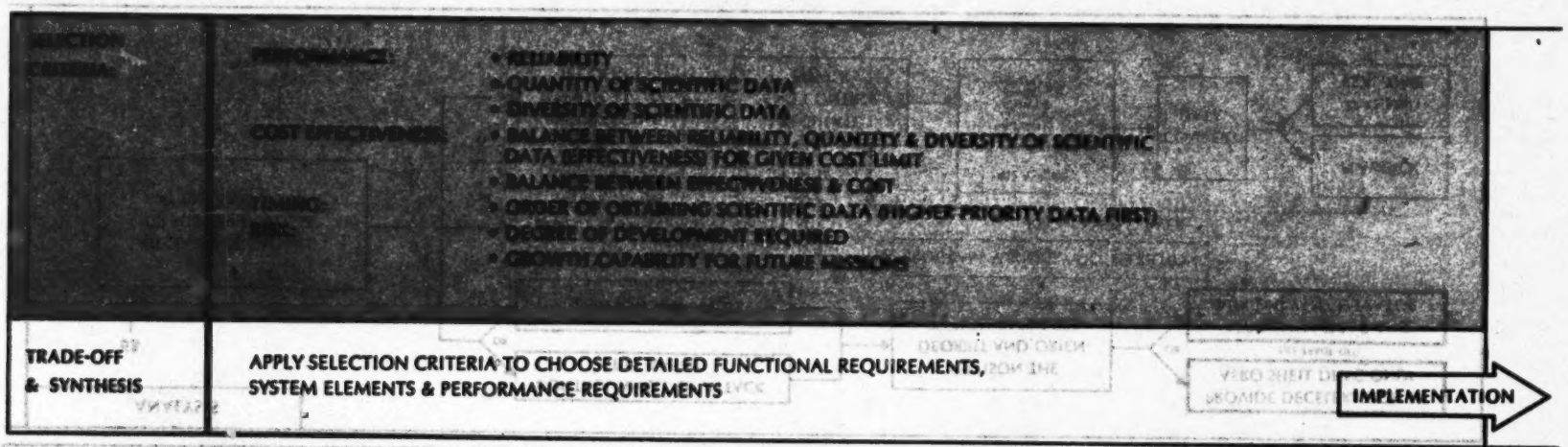
IMPLEMENTATION

TRANSLATION

FUNCTIONAL REQUIREMENTS:

		DURATION	EXTERNAL ENVIRONMENT	RELIABILITY GOAL
50	SURVIVE DEORBIT PHASE	1 TO 12 HRS.	N.C. (NOT CRITICAL)	.99
51	MEASURE & TRANSMIT ENTRY PERFORMANCE	100 TO 470 SEC.	(SEE CONSTRAINTS)	.95
52	SURVIVE ENTRY ENVIRONMENT	100 TO 470 SEC.	(SEE CONSTRAINTS)	.99
53	MEASURE & TRANSIT ATMOSPHERIC & SURFACE DATA TO IMPACT	60 TO 180 SEC.	(SEE CONSTRAINTS)	.95


IMPLEMENTATION
ANALYSIS:
APPLICATION OF CONSTRAINTS TO DETERMINE POSSIBLE:
1) DETAILED FUNCTIONAL REQUIREMENTS
2) SYSTEM ELEMENTS FOR IMPLEMENTING FUNCTIONAL REQUIREMENTS
3) SYSTEM ELEMENTS PERFORMANCE REQUIREMENTS
ANALYSIS
53
DECELERATE CAPSULE TO SUBSONIC SPEEDS AT 10,000 FT. (MIN)
CONTROL ANGLE OF ATTACK AT RE-ENTRY
OR
ENTER AT ANY ANGLE
SUPPLY POWER
REGULATED POWER
PROGRAM THE CAPSULE EVENT SEQUENCE
REGULATE AND CONTROL POWER
REG. POWER
MEASURE:
TEMPERATURE
DENSITY
PRESSURE
COMPOSITION
ALTITUDE
WIND
SURFACE (TV)
CONVERT DATA
OR
PLAYBACK
TRANSMIT REAL TIME
REGULATED POWER
PROGRAM AUXILIARY DECELERATION
JETTISON THE DEORBIT AND ORIENTATION PACKAGES
OR
PROVIDE DECELERATION BY AERO SHELL DRAG ONLY
(SEE TRADE-OFF)
AERO SHELL DRAG AND AUXILIARY DECELERATOR


SELECTION CRITERIA
PERFORMANCE:
COST EFFECTIVENESS
TIMING:
RISK:
• RELIABILITY
• QUANTITY OF SCIENTIFIC DATA
• DIVERSITY OF SCIENTIFIC DATA
• BALANCE BETWEEN RELIABILITY, QUANTITY & DIVERSITY OF SCIENTIFIC DATA (EFFECTIVENESS) FOR GIVEN COST LIMIT
• BALANCE BETWEEN EFFECTIVENESS & COST
• ORDER OF OBTAINING SCIENTIFIC DATA (HIGHER PRIORITY DATA FIRST)
• DEGREE OF DEVELOPMENT REQUIRED
• GROWTH CAPABILITY FOR FUTURE MISSIONS
TRADE-OFF & SYNTHESIS
APPLY SELECTION CRITERIA TO CHOOSE DETAILED FUNCTIONAL REQUIREMENTS, SYSTEM ELEMENTS & PERFORMANCE REQUIREMENTS
IMPLEMENTATION
TRADE-OFF
RELIABILITY REQUIREMENT
MAXIMUM RATINGS
RELIABILITY
QUANTITY OF DATA
DIVERSITY OF DATA
DEGREE OF DEVELOPMENT REQUIRED
GROWTH
FUNCTIONAL REQUIREMENT
ALTERNATIVES
15 7 10 10 10
TOTAL RATING
53 MEASURE AND TRANSMIT ATMOSPHERIC & SURFACE DATA TO IMPACT
.95
(a) PROVIDE DECELERATION BY AERO SHELL DRAG ONLY
15 2 3 10 3
33
(b) AERO SHELL DRAG AND AUXILIARY DECELERATOR
10 7 10 5 10
42

OUTPUT:

1) SYSTEM ELEMENTS

2) SYSTEM ELEMENT PERFORMANCE REQUIREMENTS

3) MISSION PROFILE

IMPLEMENTATION

OUTPUT

FUNCTION	SYSTEM ELEMENTS	PERFORMANCE REQUIREMENTS	REL.	LIFE	ENVIRONMENT	COST
# 53	1 HIGH DRAG SHAPE	1 PROVIDE C_D = 1.2 to 1.5	.999	N.C.	N.A.	–
	2 AUXILIARY DECELERATOR	2 INCREASE DRAG IN SUBSONIC REGIME BY FACTOR OF THREE	.990	N.C.	(SEE CONSTRAINTS)	–
	3 DEORBIT AND ORIENTATION SEPARATOR	3 (NOT CRITICAL)	.995	N.C.	N.C.	N.C.
	4 ETC.	4 ETC.				

SYSTEM ELEMENTS DEFINITION CYCLE (PLANETARY ENTRY PRODUCT AREA)—IMPLEMENTATION

Fig. 7

OBJECTIVE:	IMPLEMENT SYSTEM ELEMENTS WITH REQUIRED PERFORMANCE
CONSTRAINTS:	**PHYSICAL:** WEIGHT, SIZE & PERFORMANCE LIMITATIONS **FINANCIAL:** WITHIN SYSTEM ELEMENT COST ALLOCATIONS **TIMING:** ELEMENTS TO BE FLIGHT PROVEN BY CERTAIN DATE **POLICY:** USE ONLY FLIGHT PROVEN ELEMENTS–MAXIMUM UTILIZATION OF ELEMENTS FROM PREVIOUS MISSIONS
TRANSLATION:	ALLOCATION OF ELEMENTS INTO CATEGORIES & COMPONENTS → IMPLEMENTATION

TRANSLATION

CATEGORIES		SYSTEM ELEMENTS
A	STRUCTURE	1 AEROSHELL
		➡ 2 IMPACT ATTENUATION
		3 CAPSULE ERECTION
		4 CAPSULE ANCHOR
		5 SEALANT

CATEGORIES		SYSTEM ELEMENTS
B	RETARDATION	1 AUXILIARY DECELERATOR
		➡ 2 DECELERATOR PROGRAMMER
C	DATA HANDLING	1 DATA CONVERTER
		2 RECORDER
		3 CAPSULE PROGRAMMER
D	ETC. --	

ANALYSIS: APPLICATION OF CONSTRAINTS TO DETERMINE POSSIBLE:

1) DESIGN APPROACHES & CAPABILITIES
2) DESIGN REQUIREMENTS, INCLUDING
   - WEIGHT
   - VOL
   - POWER
   - RELIABILITY
   - LIFE
   - COST
   - ETC.

IMPLEMENTATION

ANALYSIS						
SYSTEM ELEMENTS		POSSIBLE APPROACHES	CAPABILITY	SYSTEM ELEMENTS	POSSIBLE APPROACHES	CAPABILITY
A-2	IMPACT ATTENUATOR	(a) BALSA WOOD (END GRAIN)	16,000-19,000 FT. LB. /LB.	B-2 DECELERATOR PROGRAMMER	(a) G-SWITCH	SENSING A SPECIFIED DECELERATION LEVEL
		(b) PHENOLIC GLASS HONEYCOMB	10,000-26,500 FT. LB. /LB.		(b) BAROSWITCH PLUS G-SWITCH	SENSING A SPECIFIED ATMOSPHERIC PRESSURE & DECELERATION LEVEL
		(c) PNEUMATIC	1,150-11,400 FT. LB. /LB.		(c) TIMER PLUS G-SWITCH	SENSING A SPECIFIED TIME FROM ENTRY & DECELERATION LEVEL
		(d) RETRO-ROCKETS	30,000-45,000 FT. LB. /LB.		(d) INTEGRATING ACCELEROMETER	SENSING A SPECIFIED VELOCITY DURING ENTRY

SELECTION CRITERIA:	**PERFORMANCE:** • RELIABILITY • WEIGHT / VOLUME / POWER • LIFE • COST **COST EFFECTIVENESS:** • BALANCE BETWEEN RELIABILITY, WEIGHT, VOLUME, POWER, LIFE & COST **TIMING:** • DEVELOPMENT CYCLE **RISK:** • DEGREE OF DEVELOPMENT REQUIRED • DEGREE OF TOLERANCE TO ENVIRONMENTAL UNCERTAINTY **POLICY:** • GROWTH CAPABILITY FOR FUTURE PLANETARY ENTRY SYSTEMS
TRADE-OFF & SYNTHESIS	APPLY SELECTION CRITERIA TO CHOOSE DESIGN APPROACHES FOR DEVELOPMENT → IMPLEMENTATION

TRADE-OFF

* SYSTEM TRADE-OFF STUDIES REQUIRED TO ASSESS RELATIVE WEIGHTS AND RELIABILITY

** TENTATIVELY JUDGED TO BE THE MORE PROMISING

SYSTEM ELEMENTS	POSSIBLE APPROACHES	MAXIMUM RATING	RELIABILITY 20	WEIGHT 15	DEGREE OF DEVELOPMENT REQ. 10	GROWTH 15	TOTAL RATING
A-2	(a) BALSA WOOD (PLUS PARACHUTES)		*	*	8	8	
IMPACT ATTENUATOR	(b) PHENOLIC GLASS HONEYCOMB (PLUS PARACHUTES)		*	*	10	10	* *
	(c) PNEUMATIC (PLUS PARACHUTES)		*	*	6	5	
	(d) RETRO-ROCKETS		*	*	10	15	* *

● SOLUTION REQUIRING NO NEW DEVELOPMENT

SYSTEM ELEMENT	POSSIBLE APPROACHES	MAXIMUM RATING	RELIABILITY 20	WEIGHT 5	POWER N.C.	TOLERANCE TO ENVIRONMENT UNC. 20	GROWTH 15	TOTAL
B-2	(a) G-SWITCH		20	5	–	5	8	38
DECELERATOR PROGRAMMER	(b) BAROSWITCH PLUS G-SWITCH		16	4	–	10	10	40
	(c) TIMER PLUS G-SWITCH		18	3	–	12	15	48
	(d) INTEGRATING ACCELEROMETER		16	4	–	18	13	51

OUTPUT: **ADVANCED DEVELOPMENT REQUIREMENTS:**

1) **DESIGN APPROACHES BEYOND PRESENT CAPABILITY**
2) **DESIGN REQUIREMENTS FOR APPROACHES BEYOND PRESENT CAPABILITY**
3) **TIMING**

IMPLEMENTATION

OUTPUT

ADVANCED DEVELOPMENT REQUIREMENTS:

SYSTEM ELEMENT	DESIGN APPROACH	REQUIREMENTS	TIMING
A-2 IMPACT ATTENUATOR	(b) PHENOLIC GLASS HONEYCOMB	(b) (TO BE SPECIFIED AFTER SYSTEM STUDIES ARE MADE)	TECHNOLOGY MUST BE DEVELOPED BY THE END OF 1969
	(d) RETRO-ROCKETS	(d) (TO BE SPECIFIED AFTER SYSTEM STUDIES ARE MADE)	
	(e) NEW PASSIVE APPROACH	(e) REDUCE WEIGHT TO 30% OF PHENOLIC GLASS HONEYCOMB WITH "G" LEVELS ATTENUATED TO LESS THAN 300 LBS. AT IMPACT	

ADVANCE PLANNING CYCLE FOR TECHNOLOGIES (PLANETARY ENTRY PRODUCT AREA)

Fig. 8

OBJECTIVES:	DEVELOP REQUIRED TECHNOLOGIES	
CONSTRAINTS:	**PHYSICAL:**	• FACILITY & PERSONNEL AVAILABILITY
	FINANCIAL:	• FUNDS AVAILABLE FOR PRODUCT AREA
	TIMING:	• TECHNOLOGY MUST BE DEVELOPED BY CERTAIN DATE • FACILITY & PERSONNEL AVAILABILITY
	POLICY:	• MAKE MAXIMUM USE OF TECHNOLOGIES DEVELOPMENTS FROM OTHER PRODUCT AREAS
TRANSLATION:	CATEGORIZE ADVANCED TECHNOLOGY REQUIREMENTS: TECHNIQUE, MATERIALS, COMPUTER PROGRAMS AND SIMULATION	
ANALYSIS	APPLICATION OF CONSTRAINTS TO DETERMINE POSSIBLE TECHNOLOGIES DEVELOPMENT: 1) TASKS 2) SCHEDULES 3) DECISION POINTS 4) FUNDING APPROACHES	

SELECTION CRITERIA:	**PERFORMANCE:** • CRITICALITY OF TECHNOLOGY TO MISSION SUCCESS • DEVELOPMENT COST **COST EFFECTIVENESS:** • BALANCE BETWEEN CRITICALITY & COST **TIMING:** • COMPATIBILITY BETWEEN NEEDED DATA & EFFICIENT UTILIZATION OF RESOURCES **RISK:** • PROBABILITY OF SUCCESSFUL TECHNOLOGY DEVELOPMENT **POLICY:** • EFFICIENT UTILIZATION OF RESOURCES
TRADE OFF & SYNTHESIS	APPLY SELECTION CRITERIA TO CHOOSE TECHNOLOGIES DEVELOPMENT TASKS
OUTPUT:	ADVANCED TECHNOLOGIES DEVELOPMENT PLAN: 1) TASKS 2) SCHEDULE 3) DECISION POINTS 4) FUNDING APPROACH

The analysis step involves the application of constraints to determine the possible system definitions in successive stages of increasing detail. For instance, the procedure is first to analyze top-level functional requirements into more detailed requirements; second, to identify the system elements needed in implementation of these functional requirements; and third, to identify the system element performance requirements necessary to achieve the desired results.

The key to the successful execution of the analysis step is to judiciously choose the proper depth of analysis. If experience indicates that there is nothing new about a particular functional requirement, so far as implementation is concerned, then the analysis is not continued any further. We should keep in mind that the purpose of this procedure is not to design the system, but to identify advance development requirements.

Having identified the possible requirements for the functional and the system elements, we now evaluate them through trade-offs to determine how well they meet objectives. Again, in order to test the validity of conclusions, we need to perform a sensitivity analysis to determine the effect of small variations in the value assessment on overall conclusions. The output of this cycle is a list of all the system elements required to implement the system, the performance requirements for the system elements, and a mission profile which is a time history of all events and functions. As depicted in Fig. 6 performance requirements are not necessarily identified for each of the system elements if it has been judged that nothing new is required to implement a particular element. In the same token, some of the requirements on the system elements, such as life, environment or cost may not have to be identified explicitly, if they are judged to have no bearing on advance development requirements.

System element definition cycle

In this cycle, as outlined in Fig. 7, we analyze the system elements that require further study. We need to determine their design requirements and design approaches at this time, so we can assess the necessity for advanced development.

To determine the system element design requirements, the elements are first structured into categories such as structures, retardation, data handling, etc., for ease of analysis. Typical constraints identified at this level are overall lander weight, size limitations, as well as policy constraints prescribing the use of only flight-proven elements. As indicated in Fig. 7 some of these trade-offs reflect that there are a number of approaches that could successfully meet the system element requirements. In this case, no further analysis is required, and that particular element is eliminated from further planning consideration. A situation frequently encountered in this cycle is that during a trade-off study we may realize that additional study is required before the possible approaches can be traded-off against the criteria. This could also occur in the other two cycles. The assembly of these study tasks that are required to identify proper design approaches is called a System Study Plan. We use this plan to map out the additional analyses and trade-off studies needed to identify the advanced development requirements.

The output of the System Element Definition Cycle is a list of Advance Development Requirements in terms of the design approaches for a specific system element, the performance requirement of these design approaches, and the timing as to when the technology must be available.

TECHNOLOGY ADVANCE PLANNING CYCLE

Once the technology deficiencies have been identified for the system under study, plans must be developed to achieve this technological capability. The procedure for developing these plans, which is standard and straightforward, is summarized in Fig. 8.

IMPLICATIONS FOR THE FUTURE

The Systems Approach, used essentially as described here, has proven an effective tool for planning advanced systems and technologies. When skillfully implemented, the Systems Approach provides a disciplined technique for:

Effective identification of advanced requirements for complex systems.

Thorough assessment of the effect of changes in environment on the development plans.

Timely identification of problems and study requirements in the conceptual phase of a program.

Accurate documentation tracing the chain of decisions and supporting reasons for communicating and justifying recommended courses of action. Use of the Systems Approach in planning is justified in all types of applications where resources are limited and the systems are sufficiently complex that an intuitive or an inductive approach would lack the necessary thoroughness. The precision of this approach is limited only by the validity of the original objectives, the constraints, and the criteria, and the degree to which they can be quantified. In addition to being used in the aerospace business the System Approach is presently being applied to such areas as oceanics, education, and water management. It is reasonable to predict that the applications of this approach to advanced planning will expand, and will provide substantiated bases for decision-making related to public programs and to the management of resources on a national order of magnitude.

The Systems Approach: A Tool for the Congress

(By Robert L. Chartrand, Information Sciences Specialist, Science Policy Research Division, Library of Congress, Legislative Reference Service)

INTRODUCTION

From the days of its founding, the United States has prospered and achieved a position as a world power because of the initiative, ingenuity, and industry of its leaders and citizens. As technological changes were introduced, their impact was felt by all facets of society: business, government, and the academic elements.

The period since 1940 has been one of spectacular growth and activity. Both in the realm of ensuring national security and in striving successfully to provide a rising standard of living, the technological achievements have been impressive. The realization has developed, however, that as richly endowed as this country may be, its resources are not unlimited. The requirement to assess what steps must be taken to preserve our heritage, while still administering to the needs of a growing, ever more complex populace, are being articulated in many quarters.

The essence of the challenge facing contemporary leadership is set forth in the recent report of the National Commission on Technology, Automation, and Economic Progress:

"Our problem is to marshall the needed technologies, some of which are known and some not yet known. If we are to clean up our environment, enhance human personality, enrich leisure time, make work humanly creative, and restore our natural resources, we shall need inventiveness in the democratic decision making process as well as in the needed technologies." [1]

As new equipment and techniques have been developed, there has been an imperative need for a reexamination of the role of technology in solving problems in the public domain. Similarly, the pressures upon the leadership of the Nation have multiplied, forcing that leadership to scrutinize anew its responsibilities and goals. In *Technology and the American Economy* the course of action is emphasized:

"We shall also need to find creative combinations of public and private initiative, as some of the goals of the future may not be achievable through private initiative; leadership will be required by government—Federal, State, and local—with important roles to be played by universities and non-profit institution." [2]

One means of examining and coping with the problems of this age is found in the so-called "systems approach." As the leaders and planners in politics, industry, and science have faced such major problems as air and water pollution, transportation, urban renewal and expansion, natural resources preservation, and solid waste disposal, they have come to realize that a critical facet of management planning is that of structuring salient information so that relationships become apparent and meaningful.

More elaborate means of setting forth agencies' programs and needs have been evolved and the "systems approach," which had been initiated some years

[1] National Commission on Technology, Automation, and Economic Progress. Technology and the American Economy, v. 1. Washington, U.S. Govt. Print. Off., Feb. 1966. p. xiii.
[2] Ibid.

earlier,[3] has become an accepted part of management's mode of operation. The techniques connected with systems analysis and operations research, and the "tools" commonly identified with automatic data processing (ADP) now are very real to those in government, particularly in the Executive Branch. The ways in which the Legislative Branch of the Federal government is commencing to perceive and utilize the systems approach will be developed further in this study.

THE SYSTEMS APPROACH: BACKGROUND AND DEFINITIONS

Before delving into current efforts by the United States Congress to utilize the systems approach in its decision-making role, and in dealing with public problems through legislation, a brief review of the development of the concept may be useful. The origins of the systems approach usually are traced back to the pioneer endeavors of Frederick W. Taylor who commenced studying the production of steel prior to World War I.[4] Known as the originator of "scientific management," he propounded the revolutionary idea that an organizational element was needed in any establishment which was dedicated to the analysis of the performance of operations.

Executives responsible for the development and production of military items in the period from 1920 to 1940 recognized that Taylor's concept was sound, just as they came to realize that their past experience in producing war material was not sufficient to successfully respond to their new challenges. In Great Britain, the innovation of radar forced the decisionmakers to take a hard look at the type of men who were comprising a development team. A group, generally referred to as "Blackett's circus," was formed under the leadership of Professor P.M.S. Blackett, a Fellow of the Royal Society and a Nobel Laureate.[5] The interdisciplinary nature of this team was to be repeated countless times in the years to come, but it was unique and much questioned in those days.

The term "operational research" came into being, and was soon adopted by scientific groups active in the United States, Canada, and France. After the end of World War II, many of the persons active in the scientific analysis of operations in the military reentered the private sector, both in industry and the academic world. These scientists and engineers found that their experience in operations research could be applied against new problems.

Within the realm of defense planning in the United States a need was identified for a new type of institution that could conduct complex studies over an extended period of time, utilizing the full spectrum of tools and techniques available. To fulfill this requirement the RAND Corporation was established in 1946.[6] Its work and that of similar not-for-profit and other "think type" groups has been well documented and does not require elaboration at this time.

Systems analysis and operations research became a formal part of Federal management activity with the Kennedy administration. Secretary of Defense Robert McNamara believed that systematic quantitative analyses could be useful in solving many defense problems. The man responsible for injecting this thinking into the Pentagon mainstream was Charles J. Hitch, formerly of RAND, who became Comptroller of the Department of Defense (DOD). Hitch saw no need to distinguish between the terms "systems analysis" and "operations research," but did characterize the former in this way:

"Systems analysis at the national level . . . involves a continuous cycle of defining military objectives, designing alternative systems to achieve these objectives, evaluating these alternatives in terms of their effectiveness and cost, questioning the objectives and the other assumptions underlying the analysis, opening new alternatives, and establishing new military objectives."[7]

Under the leadership of Hitch a new concept called the Planning Programming-Budgeting System (PPBS) was established within DOD which was judged to

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[3] Roessner, J. David. Systems analysis: definition, scope, and characteristics. Washington, Legislative Reference Service, Library of Congress, Oct. 4, 1966. pp. 6–8.

[4] Taylor, F. W. The principles of scientific management. New York, Harper and Brothers, 1911. 77 p.

[5] Trefethen, Florence N. A history of operations research. *In* Operations research for management, v. 1. Joseph F. McCloskey *and* Florence N. Trefethen, *ed.* Baltimore, The Johns Hopkins Press, 1954. pp. 5–10.

[6] Smith, Bruce L. R. The RAND Corporation. Cambridge, Harvard University Press. 1966. 332 p.

[7] Hitch, Charles J. Plans, programs, and budgets in the Department of Defense. *In* Operations research, Jan.–Feb. 1963. p. 8.

be so effective that in 1965 President Johnson directed the Bureau of the Budget to place the system in effect in all Executive agencies and establishments.[8] Thus, the Executive Branch was committed to a major effort to apply the systems approach to some of its key management as well as operational activities.

Augmenting the gradual development of new techniques and procedures has been an increasing reliance by the Federal government on automatic data processing (ADP) equipment and procedures. Whereas only 90 ADP installations were in operation in 1956, 2,623 electronic computers and punched card units were projected for FY 1966.[9] Another indication of the Federal government involvement in this area is that $1,292,000,000 (estimate) will be spent in FY 1967 for ADP equipment and services.[10] Since virtually all of these devices are situated within the Executive Branch, the agencies and departments have become increasingly sophisticated over the past decade in using ADP in support of many planning and operational functions.

CONGRESS AND ITS WORKING ENVIRONMENT

The Congress of today is in many ways different from its predecessor bodies. In the First Congress, the 65 members of the House of Representatives came from constituencies averaging 33,000 persons. The total work load of that group resulted in 118 public and private acts and resolutions being enacted.[11] Today's Congressman represents an average of 450,000 constituents, and the number may double in the next 40 years.

The demands upon the time and energies of the member of the contemporary Congress are legion. In the 89th Congress, 26,566 measures were introduced, and 4,016 legislative measures were passed.[12] Besides spending hours attending committee hearings—and each Congressman is a member of multiple committees and subcommittees—there were, for example, in the House of Representatives during the First Session of the 89th Congress 182 quorum calls, 201 Yea and Nay calls, and hundreds of teller, division, and voice votes.[13]

As the Congressman strives to function as an enlightened decisionmaker, the quality of information upon which he renders his judgments becomes a vital factor. In discussing decision making in Congress, Dr. James A. Robinson, Professor of Political Science at the Ohio State University, has reinforced the importance attached to this key area by commenting that "as problems proliferate, the amount of information required as a basis for making policy decisions also radically increases. In consequence, no legislator can be an expert on more than a few policy issues."[14] The information which is sought has four classical characteristics: it must be complete, accurate, timely, *and relevant.*[15] Where the Congressman and his staff must comprise on one or more of these elements, the resultant judgment may suffer.

Some authorities feel that the trend has been for the Congress to yield more and more of its delegated responsibilities to the Executive. But the Congress continues, by the authority set forth in the Constitution, to ensure that the Executive carries out its intentions in three ways—through its lawmaking power, appropriations power, and through investigations. Today there is an effort underway to strengthen the role of the Congress in policy making.

The Congressman seeks to identify and employ new ways and means for functioning more effectively. An American Political Science Association survey indicated that a typical work-week for the "average" Congressman in 1965 was 59.9 hours.[16] Where can the member and his overworked staff turn for asistance

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[8] Executive Office of the President. Bureau of the Budget. Planning-programming-budgeting. Bulletin No. 66–3 to the heads of executive departments and establishments. Washington, Oct. 12, 1965. 13 p.

[9] Executive Office of the President. Bureau of the Budget. Inventory of automatic data processing equipment in the Federal government. Washington, July 1966. Chart 1, p. 7.

[10] Ibid., chart 4, p. 10.

[11] Galloway, George B. History of the House of Representatives. New York, Thomas Y. Crowell, 1961. Appendix G, p. 303.

[12] Congressional record. [Daily ed.] (Washington), v. 112, Nov. 21, 1966. p. D1045.

[13] Ibid.

[14] Robinson, James A. Decision making in Congress. *In* Congress: the first branch of government. Washington, American Enterprise Institute for Public Policy Research, 1966. p. 265.

[15] Chartrand, Robert L. Automatic data processing and the American political campaign. Washington, Legislative Reference Service, Library of Congress, Sept. 15, 1966. p. 2.

[16] Rumsfeld, Donald. The operation of the Congressional office. *In* We propose: a modern Congress. Mary McInnis, *ed.* New York, McGraw-Hill, 1966. p. 290.

in carrying out their duties? For research support, they may turn to the Legislative Reference Service of the Library of Congress, the various Executive Branch elements, or to the private sectors of society. Increasingly, a number of Congressmen are starting to examine whether or not the systems approach may be of some aid in handling their day-to-day problems.

PROPOSALS TO AID THE CONGRESSMAN

There are several identifiable alternatives for determining how systems analysis or operations research might be used to good purpose by the Congress. One way would be a staff or task force study of the existing situation and possible remedies. Occasionally, an individual member has undertaken such a study, and isolated improvements in office procedures (e.g., handling constituent correspondence) have resulted. In mid-1966, a volume entitled *We Propose: A Modern Congress*[17] by the House Republican Task Force on Congressional Reform and Minority Staffing was published. This book features chapters on many recommended improvements for the Congress including the use of ADP, changes in members' office operations, and other technological mechanisms which might be utilized.

A second way of looking at the Congress, and how it might operate more effectively, was evidenced by the establishment during the 89th Congress of the Joint Committee on the Organization of the Congress, jointly chaired by Senator A. S. Mike Monroney and Rep. Ray J. Madden. The final report of this committee[18] includes a number of recommendations dealing with techniques and procedures for improving the performance and the *modus operandi* of the members and committees of the Congress. These are embodied in the Legislative Reorganization Act of 1967, to be considered for passage during the 90th Congress.[19]

A third way of developing new ideas has been to encourage an outside group to study the activities of the Congressman and how they might be improved. Such an effort was undertaken two years ago by The American Enterprise Institute for Public Policy Research. A group of scholars was commissioned to examine various aspects of Congressional operations and prepare separate studies on how the Congress "might be aided in its work to achieve a good society, counting as part of that good society the legislative way of life itself."[20] The resulting studies were combined in a book called *Congress: The First Branch of Government*, which is being read widely on Capitol Hill. Another insight into the functioning of the Congress was taken by the Arthur D. Little Company, which prepared a *Management Study of the U.S. Congress* in 1965.[21] Portions of this interpretation then were included in an NBC News television presentation entitled "Congress Needs Help."

Finally, the Congress has begun to look at what might be done through legislation to provide technological support for its own activities. Towards the end of the Second Session of the 89th Congress, Rep. Robert McClory of Illinois introduced a bill (H.R. 18428)—reintroduced in the 90th Congress as H.R. 21 to establish an automatic data processing facility to support the Congress. In a speech on the floor of the House of Representatives, he pointed out that the Congress "must use every possible mechanism to insure that Congress executes its traditional responsibilities."[22] He and a bi-partisan group of supporters in the House of Representatives have stressed the importance of using ADP and modern program evaluation techniques in support of Congressional budgetary review, in this way providing the members a logical way to comprehend and respond to the PPBS mode of operation within the Executive Branch. Other priority applications named by him for utilizing automatic data processing and the systems

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[17] McInnis, Mary, *ed.* We propose: a modern Congress. New York, McGraw-Hill, 1966. 338 p.

[18] U.S. Congress. Joint Committee on the Organization of the Congress. Final report. (89th Cong., 2nd Sess., Senate Report No. 1414.) Washington, U.S. Govt. Print. Off., 1966. pp. 4–7.

[19] U.S. Congress. Joint Committee on the Organization of the Congress. Legislative reorganization act of 1967. (90th Cong., 1st sess., Senate Report No. 1.) (Washington, U.S. Govt. Print. Off., 1967.) 55 p.

[20] The American Enterprise Institute for Public Policy Research. Congress: the first branch of government. Washington, 1966. Frontispiece.

[21] A. D. Little Company, Inc. Management study of the U.S. Congress. Report to NBC News. Nov. 24, 1965. 37 p.

[22] McClory, Robert. An automatic data processing facility to support the Congress. Remarks in the House. Congressional record [Daily ed.] (Washington), v. 112, Oct. 19, 1966, p. 26787.

approach included the preparation of legislative histories of bills, and the establishment and maintenance of selected Federal data in machine-readable form.

Congressman McClory acknowledges that "few of us [in Congress] are qualified to discuss in detail the power of the electronic computer or the fine points of systems analysis procedure," but urges their selective utilization, stressing that "the future of the United States resides in the efficacy of its decision makers, whose judgments are rendered with perspective and knowledge." [20]

Senator Hugh Scott of Pennsylvania, also active in striving to obtain an ADP facility for the Congress, prepared an amendment (No. 63) which was approved by the Senate on Feb. 16, 1967, to the Legislative Reorganization Act of 1967. In delineating the purpose of this proposed new capability to assist the Congress, Senator Scott stated:

"The requirements of this age—reflected in the broad spectrum of issues facing the Congress—can be coped with only by the utilization of all available human and technological resources." [21]

After noting many applications to which the facility could render useful, time-saving support to the Congressman and their staffs, Senator Scott concluded with these words:

"The electronic computer and the systems techniques connected with its use are simply tools for use by the decision-maker. They are designed to help provide that information which is necessary to make balanced, accurate decisions." [22]

Many areas of Congressional activity appear to lend themselves to the systems approach. In a report prepared for general distribution to the Congress entitled "Automatic Data Processing for the Congress," a number of possible applications were identified and discussed.[23] In some instances, the area in focus might be the Congress as a whole, or a single chamber; in other cases, the functioning committee or individual Congressman was seen as the main beneficiary. Included for consideration were: data showing the status of pending legislation, an automated index-catalogue of Congressional documents, current information on issues up for vote, an automated schedule of committees' meetings and hearings, histories of committee action in ADP form, appropriations statistics and information, and an automated Selective Dissemination of Information (SDI) system to retrieve key items of research value to the Congressman.

There has been evidence presented before the Joint Committee on the Organization of the Congress that the application of systems analysis, operations research, and automatic data processing techniques to the problems of the Congressman in his legislative role merits consideration.[24] Similarly, many feel that the constituent-oriented activities of the Congressman can be made less time-consuming through the use of the systems approach. One Senator allowed a consulting firm to analyze his office procedures for handling constituent correspondence. The systems analysis showed that automatic data processing, properly employed, plus some changes in the human operations could result in freeing staff persons for other, more valuable work.

The member of Congress, then, like any other executive in business or government, must attempt to allocate his personal and staff resources as efficiently as possible. Unnecessary work detail must be reduced and the amount of time available for sound decision-making increased. There is no magic in systems analysis or electronic computers. Much can be done, however, to aid the legislator. As Kenneth Janda notes in his contribution to the volume *Congress: The First Branch of Government:*

"information systems are *not* . . . devices for grinding out policy decisions, and they are not designed to replace human judgment. Rather they are intended to provide the human decision maker—here, the Congressman—with knowledge for making informed choices." [25]

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[20] Ibid., p. 26788.

[21] Scott, Hugh. Remarks in the Senate during debate on the Legislative Reorganization Act of 1967. Congressional record. [Daily ed.] (Washington), v. 113, Feb. 16, 1967, p. S2124.

[22] Ibid.

[23] Chartrand, Robert L. Automatic data processing for the Congress. *In* Extension of remarks of Honorable Robert McClory. Congressional record. [Daily ed] (Washington), v. 113, Jan. 30, 1967, p. H729.

[24] U.S. Congress. Joint Committee on the Organization of the Congress. Organization of Congress. Hearings before the Joint Committee (89th Cong., 2nd sess., 1966). Washington, U.S. Govt. Print. Off. See, for example Part 7, p. 1119 *and* Part 15, appendix, pp. 2308–2318.

[25] Janda, Kenneth. Information systems for Congress. *In* Congress: the first branch of government. Washington, American Enterprise Institute for Public Policy Research, 1966. p. 435.

LEGISLATING A SYSTEMS APPROACH TO HELP SOLVE PUBLIC PROBLEMS

The Congress, both through its committee structure and by employing individual initiative, has taken several positive steps to improve its ability to address the many problems of the contemporary scene. Its members are asking such questions as: How much must we spend? On what types of projects? In what time phasing must this spending be executed? A recent editorial in *The Washington Post* treated the subject of "Long-Run Politics." It was stressed that "the facts of political affairs have changed from an environment in which the 'short-run' dominated into one in which all the decisive factors have become 'long-run'." [29]

From a society which empowered its representatives in Congress to place overwhelming emphasis on defense, space, and nuclear energy developmental projects—indeed, nearly 90% of all Federal R & D expenditures [30] have been in these three areas—there now is a demand for increased attention to a new set of problems.

Dr. Emmanuel G. Mesthene, Executive Director of the Harvard University Program on Technology and Society, stresses the change that must come to many organizations and agencies as they face these new problems:

"In government, agencies designed for earlier purposes must devise new mechanisms to deal effectively with such problems as the beauty of the environment and the livability of cities, the use and misuse of water and air, and the management of science for public purposes." [31]

Air and water pollution control, natural resources management, precise planning of transportation networks, master plans for urban growth and renewal—these will be achieved as the result of agonizing reappraisals and solutions based on compromise. No one is saying that there are any easy answers to the problems. In every case, the decisionmakers and planners take calculated risks; Peter F. Drucker in his "Long-Range Planning: Challenge to Management Science" suggests that

". . . while it is futile to try to eliminate risk, and questionable to try to minimize it, it is essential that the risks taken be the *right risks*." [32]

The allocation of our human resources, money, and time is of deep concern to every member of the Congress. Senator Gaylord Nelson, as chairman of the Special Subcommittee on the Utilization of Scientific Manpower of the Senate Committee on Labor and Public Welfare introduced in the 89th Congress a bill (S. 2662)—reintroduced as S. 430 in the 90th Congress—to "mobilize and utilize the scientific and engineering manpower of the nation to employ systems analysis and systems engineering to help to fully employ the nation's manpower resources to solve national problems." [33] In hearings held in Washington, D.C., and elsewhere in the United States, Senator Nelson underscored the argument that the expertise developed within the scientific community on space- and defense-related projects must now be applied against the other problems of our society. Not only must the Federal government increase its expenditures to combat pollution, urban sprawl, and natural resources decimation, but the State and local governments must do likewise. He also urged private enterprise to marshal its forces in the fight against these specters of disaster. A recent Nelson summons to mount such an effort stated:

"Nothing short of a massive effort by industry and government at every level will solve this problem. This can be done only after a total analysis of the problem and development of an overall program of action." [34]

Within the House of Representatives in the 89th Congress a group of 44 Republicans led by Rep. F. Bradford Morse of Massachusetts strongly supported the concept of establishing a National Commission on Public Management (H.R. 17310 and other bills); similar legislation (S. 3762) was introduced by Senator

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[29] Long-run politics. The Washington post, Dec. 18, 1966. p. E6.
[30] National Science Foundation. Federal funds for research, development, and other scientific activities, v. 14. Washington, U.S. Govt. Print. Off., 1965. Chart 14, p. 21.
[31] Mesthene, Emmanuel G. An experiment in understanding. *In* Technology and culture, v. 7, no. 4, Fall 1966. p. 486.
[32] Drucker, Peter F. Long-range planning: challenge to management science. *In* Management science, v. 5, April 1959. p. 240.
[33] Nelson, Gaylord. A space age trajectory to the great society. Remarks in the Senate. Congressional record. [Daily ed.] (Washington), v. 111, Oct. 18, 1965. p. 27242.
[34] U.S. Congress. Senate. Committee on Labor and Public Welfare. Special Subcommittee on the Utilization of Scientific Manpower. Scientific manpower utilization, 1965–66. Hearings before the Special Subcommittee (89th Cong., 1st sess., Nov. 18, 1965), p. 16. [Remarks by Senator Gaylord Nelson].

Hugh Scott and nine other Senators. Congressman Morse and his associates concentrated upon the need for further study of the applicability of the systems management approach to non-defense and non-space public programs. The GOP Congressmen termed their bill an "entirely new departure in American political thinking." [35] Congressman Morse went on to assert that:

"Appropriating money and shuffling papers in the bureaucracy should not be confused with problem-solving. The traditional Government approach to a complex problem is to divide it into manageable parts and to treat each of them separately. A comprehensive solution is thus impossible. The bureaucracy simply does not have the capacity to solve today's or tomorrow's problems—but private industry with the new approach is rapidly developing that capacity." [36]

Early in the 90th Congress, Senator Hugh Scott reintroduced his bill (S. 467) [37] and Rep. Morse acted similarly (H.R. 20).[38] Both Congressmen appeared before the Senate Special Subcommittee on the Utilization of Scientific Manpower to discuss with its chairman, Senator Gaylord Nelson, the possibility of merging their approach—calling for a National Commission as contained in their bills—with the emphasis on grants to States appearing in his bill (S. 430).

Another insight into the role of systems analysis in the public domain is found in the recommendations of the Subcommittee on Science Research, and Development (Hon. Emilio Q. Daddario, Chairman) of the House Committee on Science and Astronautics dealing with environmental pollution:

"To place pollution abatement on a comparable basis with other national technology programs, systems analysis and management capability should be established within the Federal Government. This approach should be used along with the "planning, programming, budgeting" technique to organize both near and long term Federal research and operational efforts in pollution abatement." [39]

The attention of the Congress to the significance of the systems approach also was solicited in Senator Edward Kennedy's Joint Resolution 187, (89th Congress), which would authorize the Advisory Commission on Intergovernmental Relations to undertake a study and the subsequent design of a "national information system utilizing advanced informational technology." [40] This system would be capable of providing local and state officials with requisite information on Federal programs and assistance. In commenting on the measure on the floor of the Senate, Senator Kennedy said:

"As I visualize this system, it would also provide the kind of systems analysis and information data necessary to enable both Congress and the administration to oversee the enactment and administration of Federal programs." [41]

The need for a joint government-business attack on these problems has been identified and is being examined across the nation. In a few cases, the States are taking the initiative in supporting systems engineering studies such as those performed for the State of California by four aerospace companies.[42] The greater portion of the burden connected with this approach resides with the Federal government, say many adherents of the systems approach. The sums to be spent are huge, and doubtless will continue to grow. This manner in which these sums are spent can affect the entire fabric of our nation for generations to come.

Congressman Henry S. Reuss, Chairman of the Subcommittee on Research and Technical Programs of the House Committee on Government Operations, raised the complain that while we are spending $3 billion annually to place a man on the moon, nothing is being allocated for research on how to develop "entirely new

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[35] Morse, F. Bradford. Managing the public business. Remarks in the House. Congressional record. [Daily ed.] (Washington), v. 112, Aug. 25, 1966. p. 19836.

[36] Morse, F. Bradford. New GOP plan for public problem solving. Press release, Aug. 26, 1966. p. 2.

[37] Scott, Hugh. Remarks in the Senate during debate on the Legislative Reorganization Act of 1967. Congressional record. [Daily ed.] (Washington), v. 113, Jan. 18, 1967. pp. S432–S434.

[38] Morse, F. Bradford. National Commission on Public Management. Remarks in the House. Congressional record. [Daily ed.] (Washington), v. 113, Jan. 10, 1967, pp. H40–H47.

[39] U.S. Congress. House. Committee on Science and Astronautics. Subcommittee on Science, Research and Development. Environmental Pollution—a challenge to science and technology. (89th Cong., 2d sess., House Report, committee print.) Washington, U.S. Govt. Print. Off., 1966. p. 7.

[40] Kennedy, Edward M. Advisory commission on intergovernmental relations. Remarks in the Senate. Congressional Record. [Daily ed.] (Washington), v. 112, Sept. 7, 1966. p. 21003.

[41] *Ibid.*

[42] U.S. Congress. Senate. Committee on Labor and Public Welfare. Special Subcommittee on the Utilization of Scientific Manpower. Scientific manpower utilization, 1965–66. *Op. cit.*, pp. 1–142.

systems of urban transportation that will transport people speedily, safely, economically, and without ruining our cities or polluting our atmosphere." [42] Another Reuss thrust: "500 million for further development of nuclear reactors, but only $1 million for the development of a better sewage treatment plant needed by most cities in the country." [43]

President Kennedy was aware of this imbalance, and in his 1963 Economic Report pointed out that:

". . . in the course of meeting specific challenges so brilliantly, we have paid a price by sharply limiting the scarce scientific and engineering resources available to the civilian sector of the economy." [44]

Thus, a genuine concern has developed on the part of top government leadership both in the Legislative and Executive brancnes that the monetary and human resources of the nation be applied judiciously to the problems of our age.

SUMMARY

The Congress, then, has demonstrated a willingness to give consideration to the utilization of modern technilogy in coping with the problems of this era. Action is being taken, both by individual members and through committees, to analyze the possible application of the systems approach—including operations analysis and research, simulation, systems management and planning, econometrics, and antomatic data processing equipment and techniques—in several areas where a Congressman must function:

1. As a legislator, responsible for scrutinizing, debating, and making decisions regarding issues of national and international scope;
2. As a representative of his district, with prime concern for its welfare, growth, and relationship to other governmental elements, and the legislative responsibilities involved; and
3. As an ombudsman of sorts, looked to by each individual constitutent as a point of reference for assistance in any one of a thousand forms.

Proposed solutions to alleviate the burden of the Senators and Representatives have emanated from many sources: internal Congressional task forces, management consultant firms, university political scientists, and industrial analysts. Many worthwhile suggestions have resulted from the "experts" occupying their own special vantage points.

Among the priority areas brought into focus has been that of establishing an automatic data processing facility which would exist exclusively to support the Congress. The proposed Legislative Reorganization Act of 1967, as amended, features a section calling for the creation of such a capability within the Library of Congress. In addition, a group of a dozen members of the House of Representatives, of bi-partisan composition, has endorsed this type of facility to perform legislation-oriented and administrative tasks for the Congress, its committees, and its individual members.

Other forces in the Congress have viewed the tools and techniques associated with the systems approach as useful resources in the battles to overcome air and water pollution, solid waste disposal, traffic congestion, and urban sprawl. Endorsement has been forthcoming both within the House of Representatives and the Senate for the projected creation of a National Commission on Public Management, which would study how systems analysis and management techniques might be utilized to resolve community, regional, and national problems in the non-defense, non-space sector.

Yet another approach, as put forth by Senator Gaylord Nelson, is to mobilize and utilize the scientific and engineering manpower of the United States to employ systems analysis and systems engineering to help solve national problems. A discernible surge in interest has appeared within the Congress to utilize the new technology. For example, the House Subcommittee on Science, Research, and Development has urged the establishment of a systems analysis and management capability to cope with pollution problems, and in another area Senator Edward Kennedy has called for the creation of an advanced information system for the exchange of information on Federal programs.

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[42] U.S. Congress. House. Committee on Government Operations. Subcommittee on Research and Technical Programs. House Government Operations Subcommittee to undertake study on how well $16 billion annual research and development budget contributes to meeting our national goals. Press release, Nov. 30, 1965. p. 1.

[43] *Ibid.*, p. 2.

[44] Economic report of the President. Washington, U.S. Govt. Print. Off., 1963. p. XXV.

The systems approach should not be viewed as a panacea for the problems of our society. It does represent, however, a resource which, when properly applied, may assist the decision-makers and planners in improving the world for this generation and those to come.

[From Harvard Business Review, March/April 1966]

Six Business Lessons From the Pentagon

(By Donald J. Smalter and Rudy L. Ruggles, Jr.)

In recent years the Department of Defense (DOD) has afforded the businessman a fruitful field of study. Though the particulars of the questions with which he and the DOD concern themselves are vastly different, the structure of these problems and the means to their solution are not. Executives in both government and business environments have as their primary responsibility the allocation of resources to maximize long-run effectiveness.

To the entrepreneur, effectiveness may mean return on investment or increased market penetration, while to the military it may imply nuclear retaliatory capability. But in each case the process of creating objectives, the techniques for analyzing alternative courses of action, and the systems for establishing strategic plans have many elements in common.

It is not surprising to find the development and implementation of such processes and techniques well advanced within the DOD, for there the number and magnitude of problems are awesome, and the current laying of plans is vital to the continued defense of the nation. Perhaps the greatest advances here have occurred since 1961, when Secretary of Defense Robert McNamara brought into existence what is now referred to as the planning-programming-budgeting process, which is used in combination with cost-benefit analysis. So successful has this framework been that in August 1965 President Johnson instructed 21 nondefense departments to institute similar planning techniques by May 1966.

From the DOD's experience come a number of concepts and techniques useful to industrial corporate planners and managers. The DOD has worked, for example, to develop:

Strategic planning by missions, allocating limited resources to each one, with plans assembled in a complete, carefully costed program package.

A large analytical and planning staff at the top organizational level.

A scheduled annual planning cycle, integrating strategy formulation with the budgeting process.

The managerial tool of posing written questions for analysis by line as well as staff groups, requiring formal answers by predetermined deadlines.

Systems analysis and planning, embodying quantitative techniques and applied to complex strategy issues.

Needs research, i.e., formalized studies to perceive problems and opportunities, as the initial phase of problem solving.

Distinctly determined steps in the planning process, derived from military concepts.

Logic-sequence network diagrams for coordinated project implementation.

A strategic planning "decision center."

It is the purpose of this article to explore these concepts in greater detail and develop from them six lessons for corporate management.

LESSONS FOR BUSINESS

To illustrate the applicability of these lessons to business, we shall refer to the work done by the company with which we are associated, International Minerals & Chemical Corporation (IMC). Of course, other companies have made similar use of the lessons; we concentrate on IMC's example simply because we are familiar with it and because it demonstrates clearly what one company can do.

In the discussion of each lesson the description of IMC's work will be accompanied by a look at the DOD's experience.

Lesson #1. Top management's primary job in any enterprise is the allocation of limited resources—for selected mission purposes, in proper dimensions of time—for the furtherance of specified objectives.

Central to this lesson is the concept of a market mission, i.e., goals for a set of individual products with related market functions and purposes. For instance, IMC initially identified nine missions of present and potential interest, some of which are shown in Exhibit I. In several of these, the company was not yet deeply involved, but the goals were ambitious. Examination of motives and purpose from a mission viewpoint led management to the inescapable conclusion that its business must be oriented to the service of customers. It concluded that its long-term expansion hopes must be directed more to the market environment and less to internal structure and skills. It reasoned that while the corporation possessed certain internal opportunities, e.g., process cost reduction and captive use of materials, the majority of its opportunities existed in the marketplace.

Product markets were categorized into three distinct groupings: agricultural, industrial, and consumer. These groups were further segmented. For example, a foundry supplies mission was delineated within the industrial category. Other missions were also defined—plant nutrition, animal health and nutrition, oil well services, flavor enhancers, and so on. This perspective helped management to do a better job of sizing up possibilities for future growth.

How were resources to be allocated in each mission area? The structure of this task may be visualized as shown in Exhibit II; here IMC is particularly useful as an example of a company with a number of product-line missions in the economy. The first vertical time slice is the annual profit plan or budget, and the next five slices represent the five-year program plan. (The missions shown here include some not shown in Exhibit I.)

EXHIBIT I. MARKET MISSIONS: THE BRIDGE BETWEEN FUNCTIONS

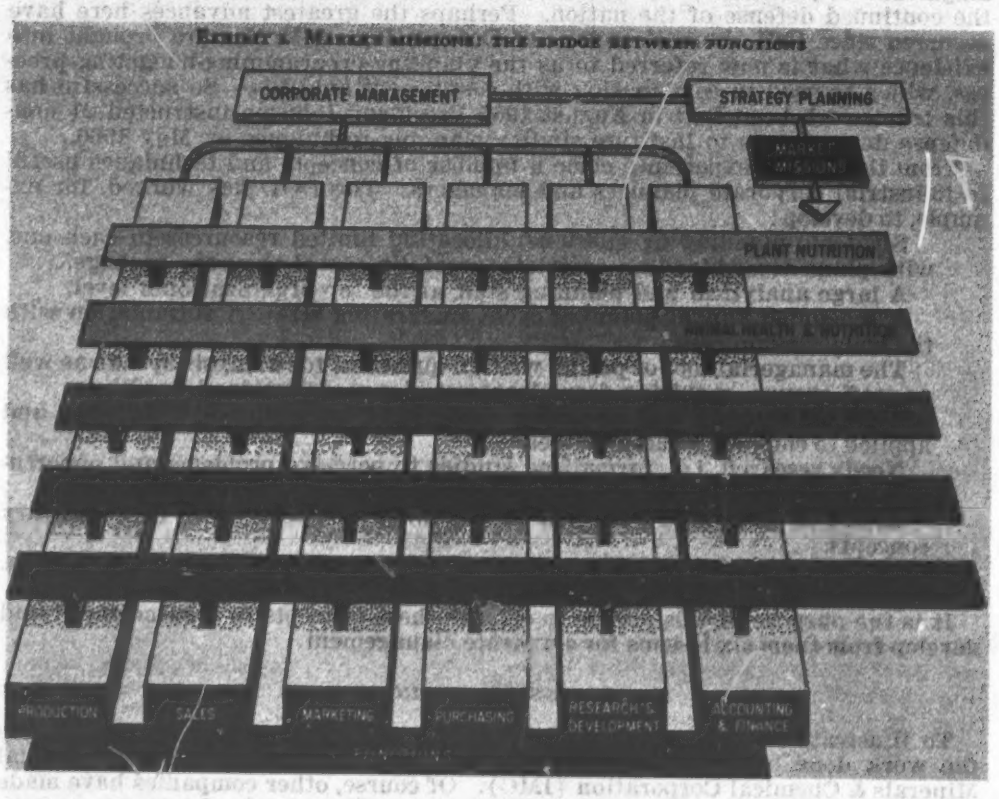
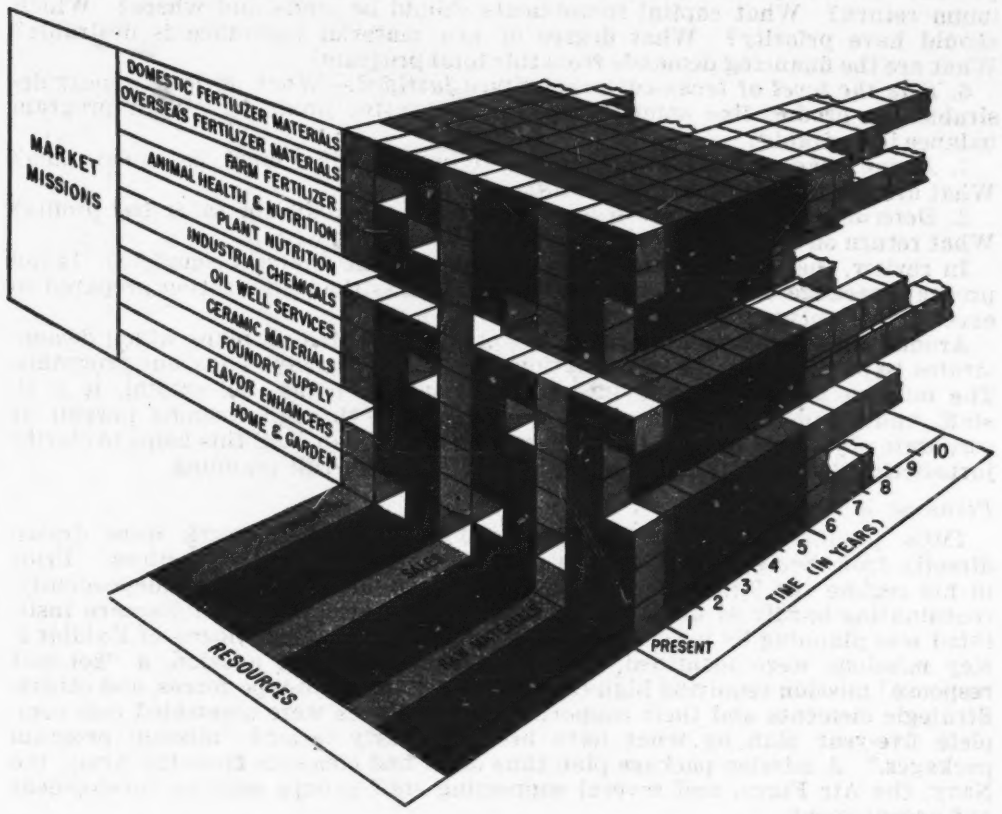


EXHIBIT II. RELATIONSHIP AMONG MARKET MISSIONS, RESOURCES, AND TIME



Complete resource and program balance is difficult to attain, but examination of product categories by mission readily points up regions of strength and weakness.

Analyzing missions

In examining the existing product-line missions of a company, management can do a more adequate job of planning goals, allocating resources, and programming expenditures if it does the following:

1. *Defines the scope of the missions as well as the broad objectives to be fulfilled.*—It must decide what proprietary directions for growth are desirable, what unique market niche is sought, what pioneering aims are worthwhile, and what synergisms with other missions can be developed.

2. *Conducts an audit to illuminate the enterprise's basic position.*—What is its scope of participation in the industry structure? Where are its greatest profit margins? What is the product life-cycle status of each product? What market share do the products possess? How well are existing capacities being utilized?

3. *Analyzes the relevant environment.*—It is vital that management look outward to be aware of the rapidly changing world in which the company exists. What is the market demand outlook for the product line? What are the present distribution channels and the possibilities of advantageously altering those channels? What impact is changing technology going to have? How will competitive changes affect the company's problems, needs, threats, and opportunities? What are the most important challenges?

4. *Establishes the momentum that the company is likely to achieve.*—Is the product line going to have continued growth, or is some major product likely to become obsolete? What are the premises or assumptions behind this projection? A profit-and-loss summary based on these answers must be assembled on a year-by-year basis.

5. *Formulates an aggressive business and sales development program.*—What goals will the organization by striving to accomplish above and beyond the point where momentum will carry it? How will the enterprise respond to the challenges that have been identified? What marketing strategies should be em-

ployed? Most importantly, how will limited resources be manipulated for maximum return? What capital investments should be made and where? Which should have priority? What degree of raw material insurance is desirable? What are the financing demands from this total program?

6. *Sets the level of technical expenditure justified.*—What projects appear desirable for product-line support and for innovative products. What program balance is desirable?

7. *Defines the organizational needs.*—What training must be undertaken? What are the recruiting requirements?

8. *Determines performance levels.*—What are the goals for sales and profits? What return on investment or return on sales is anticipated?

In review, the manager should ask himself: Is the analysis complete? Is the program-package soundly conceived? How well is the organization prepared to execute these plans?

Around these fundamentals, IMC has created a system of plans which demonstrates to participants the interrelationships and hierarchy of various programs. The mission momentum and internal development plans, the capital, R & D, staff, and acquisition plans—these are integrated through common pursuit of corporate objectives to form the corporate strategic plan. All this helps to clarify jurisdictional authority and responsibility in the overall planning.

Planning in the Pentagon

IMCs product-classification scheme and planning framework were drawn directly from Secretary McNamara's recently realigned DOD practices.[1] Prior to his regime the Army, Navy, and Air Force budgeted rather independently, coordinating hardly at all with each other's programs. What McNamara instituted was planning by missions, conceptually the military analogue of Exhibit I. Key missions were identified, e.g., a nuclear retaliation mission, a "hot-spot response" mission requiring high-capacity airlift of police-type forces, and others. Strategic elements and their supporting expenditures were assembled into complete five-year plan by what have been popularly termed "mission program packages." A mission package plan thus often had elements from the Army, the Navy, the Air Force, and several supporting staff groups such as development and procurement.

The Secretary's staff determined the needs of each of the several missions. These studies resulted in a number of highly significant moves. In mid-1961, the 1962 plan as originally submitted was hurriedly rebudgeted. Investigation had clearly revealed inadequate air- and sea-lift forces, badly in need of supplement. Nuclear retaliation capabilities were modified with greater dependence on stationary missiles, eliminating B–70's and Minutemen on railroad cars, and the Army received substantially more money for "limited" warfare. McNamara also challenged the tendency toward unilateral service plans, which had imbalances in the allocated resources for a given mission, rather than unified DOD plans. He noted, too, that often missions were ill defined. To illustrate:

While the Army had a number of divisions combat-ready at airfields for emergency airlift, the Air Force leaders were dubious about spending "their" funds for airlift capability. They much preferred to use their appropriations for bombers carrying nuclear weapons. As a result, the Air Force possessed too few planes to carry the Army's divisions overseas.

In short, introduction of the missions concept in the DOD led quickly to many important changes—billion-dollar changes, as measured by their impact on various parts of the budget.

Lesson #2: Management should integrate one-year budgeting with long-range planning in a scheduled annual cycle.

In strategic planning, it is essential to conduct studies of key issues on a year-round basis. As the year progresses, management attention must shift in order to fulfill the demands of the various phases of plan preparation. These stages are illustrated in Exhibit III. The first phase covers study of IMC's problems, needs, and opportunities as researched and identified. These matters must be investigated in detail, and weighed against corporate objectives in an attempt to resolve a strategic response. Next, specific targets or goals should be set for a long-range plan, with resources allocated within financial capabilities. Finally, after top management review and approval of the five-year plan, preparation is begun on a one-year budget.

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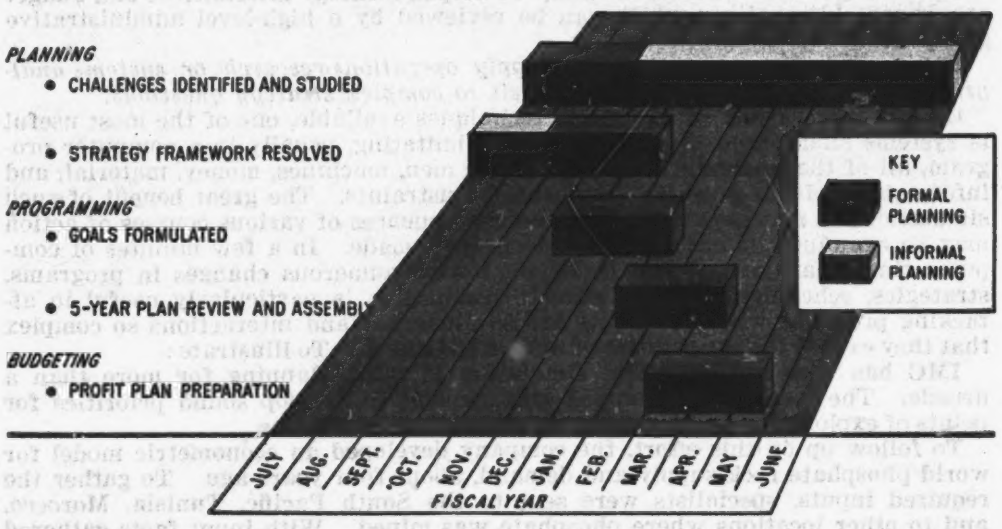
[1] See Seymour Tilles, "Strategies for Allocating Funds," HBR January–February 1966, p. 75.

EXHIBIT III. ANNUAL PLANNING CALENDAR



The DOD calls this its planning-programming-budgeting sequence. IMC has adopted essentially the same process, one that has proved to be most useful. Since IMC's fiscal year runs from July through June, the five-year plan is scheduled for presentation to the board of directors every March. As a result, sales and profit projections are already prepared when work on a detailed one-year budget commences. This greatly facilitates the preparation of the short-term profit plan and gives it a soundly conceived foundation on which to build. All the strategic aspects are essentially resolved, for ample time has been allotted to the strategic thought and analytical processes.

With minor imperfections, IMC has operated on this basis for three consecutive years. A number of other companies, such as Air Reduction Company, Inc. and Monsanto Company, have similar cycles tied to predetermined annual planning phases.[2]

DOD System

These planning phases, proved to be so useful in the corporate environment, grew from one of the major procedural shortcomings which McNamara found on entering the DOD. The Pentagon was allotting insufficient time for strategy studies — studies of what each area of the military was trying to accomplish. At budget time each year, there was a distinct tendency for the service head to allot enormous sums for continuation of present commitments, without proper analysis of the country's changing needs. His plans then were assembled in a relatively short period of time in order to meet budget deadlines, thus compounding any difficulties.

To correct this situation, McNamara and Charles J. Hitch, his Assistant Secretary-Comptroller, created the position of Deputy Assistant Secretary for Programming. This executive's function is the institution and maintenance of a "running" five-year program budget which will completely reflect all strategic decisions and all projected expenditures. This program budget may be updated monthly through a managerial system, created by Hitch, which allows proposals for program changes to pass through a prescribed set of review and approval steps and be inserted into the "running" five-year plan.

During the process of soliciting Congressional approval, a shortcoming of the DOD system becomes apparent. Congress too frequently neglects questions about program commitments or long-term strategic capabilities, and is more often interested in short-term budget implications. More logically, it should be concerned fundamentally with policy and related strategic decisions made in the DOD, i.e., strategic commitments of resources for the long term. It should not act as corporate boards of directors are often tempted to do, concentrating their efforts on the approval of capital expenditures for specific project proposals rather than on long-term program direction.

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[2] See D. M. Kiefer, "Forecasting: Business Oracles Go Modern," *Chemical and Engineering News*, July 12, 1965, p. 124.

This brings us to the need for fully developed strategy alternatives and budget cost-benefit alternatives which can be reviewed by a high-level administrative group.

Lesson #3: Management should apply operations-research or systems-analysis principles of mathematical analysis to complex strategy questions.

Of the wide variety of analytical techniques available, one of the most useful is systems simulation. It is a method of imitating, usually in a computer program, all of the interrelationships between men, machines, money, material, and information within given environmental constraints. The great benefit of such simulations to management is that the consequences of various courses of action may be examined before an actual decision is made. In a few minutes of computer time, management can experiment with numerous changes in programs, strategies, schedules, and operations. Simulation is particularly useful in attacking problems whose elements are so numerous and interactions so complex that they exceed the capabilities of human judgment. To illustrate:

IMC has used mathematical simulation in mine planning for more than a decade. The method has enabled management to develop sound priorities for points of exploration and for sequence and path of excavation.

To follow up on this effort, the company developed an econometric model for world phosphate rock supply and demand, about four years ago. To gather the required inputs, specialists were sent to the South Pacific, Tunisia, Morocco, and to other locations where phosphate was mined. With input facts gathered from every conceivable ethical source, IMC estimated competitors' costs and volumes for 3 grades from 22 sources distributed to markets in 45 countries, resulting in 5 different chemical end-products, each with critical quality constraints. The possible mine to end-use combinations numbered 2,574.

From this analysis, the delivered-cost advantages in all markets were ascertained. It would have been nearly impossible to have assimilated or manipulated this information without a computer. The ability to answer "what if" type queries proved particularly useful.

Another area in which IMC has employed simulation is ocean transportation. A least-cost shipping model has been developed which considers inputs such as worldwide demand for potash and phosphate rock, with the estimates broken down by quarters; shipping costs for various ship sizes; ship characteristics (speed, weight, draft, length); port characteristics (draft, wharf length); loading and unloading rates and costs; world bulk commodity movements; and capital investment restrictions. The analysis includes 450 equations with 3 million alternatives, and the final outputs are in the form of minimum-cost patterns of movements; numbers, sizes, and types of ships; quarterly schedules; and the most desirable commodity backhauls—information which greatly eases the process of deciding on short-term and long-term distribution strategies.

The problems that have been approached through management science techniques at IMC have been ones peculiar to its own operations, but it is not difficult to envision many areas of fruitful application for other companies. For example, both Continental Oil Company and Autonetics Division of North American Aviation, Inc. have made extensive simulations of their operations in order to grasp better the complexities of their organizations' functions. The cost of designing such systems is high, but the reward is an otherwise unattainable insight into a vital management problem.

McNamara's 76 trombones

When Secretary McNamara assumed his responsibilities in January 1961, he discovered that there was relatively poor coordination with State Department policies. Apparently there was limited liaison between the two organizations on questions of military contingency responses that would be necessary in various sectors of the world if some specific enemy action occurred. President Kennedy was understandably troubled to find that the military had drawn inadequate contingency plans for an incident which occurred soon after his inauguration—the Berlin Wall crisis.

Within three weeks after Robert McNamara assumed his DOD duties, he produced what are popularly called his "76 trombones." These were a long list of questions, often beginning with *why*. Why are you doing this? Why can it not be done in a more effective way? Why are the boundaries of certain programs set as they now are? He assigned responsibility for each question and asked for answers within three weeks. These were important fundamental questions, and from their answers he concluded that changes were urgently needed. For instance:

There was inadequate use of cost-benefit analysis as a basis for measurement of weapons systems alternatives. Service leadership did not really know the total cost of supporting a B–70. The Polaris submarine, in fact, proved far cheaper to maintain for the same unit of retaliation effectiveness. Prior to this point, the Pentagon had conducted few, if any, studies for cost comparison of alternatives.

At one time, McNamara even questioned the need for aircraft carriers, suggesting that their vulnerability perhaps outweighed their usefulness. He directed the systems analysis group to study this query. The Navy command, needless to say, was perturbed. Obviously, the DOD was not going to abandon aircraft carriers, but some longer term possibilities were identified and taken into consideration.

Because of various complaints from the military, after McNamara seized the DOD leadership initiative and instituted his revisions, the Secretary was called before a Congressional committee to explain his reforms. This was his simple, yet profound, statement: "We must first determine what our foreign policy is to be, formulate a military strategy to carry out that policy, then build the military forces to successfully conduct this strategy." [3]

To implement this philosophy, McNamara initiated several key organization changes directly related to his office. He enlisted the aid of a scholarly thinker named Charles J. Hitch from The Rand Corporation; Hitch had studied DOD problems for many years and published several perceptive articles analyzing managerial needs. That move was probably among the more significant McNamara made because of Hitch's operations-research orientation. Hitch assumed responsibility for the budgeting and operations research functions with the title of Assistant Secretary-Comptroller (until 1965, when he resigned).

McNamara also created or strengthened several key jobs related to planning:

(1) The position of Assistant Secretary for Policy Planning and International Security Affairs was established to better coordinate strategy with State Department policies, to formulate strategic planning, and to determine the broad requirements for conflict contingencies.

(2) He created the high-level office of Deputy Assistant Secretary for Systems Analysis, and appointed Dr. Alain Enthoven (now Assistant Secretary of Defense) to fill the position. This office and its supporting staff were founded to make cost-effectiveness studies of major strategic and weapons systems alternatives, using quantitative techniques. Naturally, these mathematical experts, trained in the operations research approach, were sympathetic to the use of computers for solving complex problems.

Dialogue at DOD

What impact have these changes had on DOD operations? Study of strategic questions followed by the asking of new ones has kept Department people thinking and responding with adequate programs. Part of the McNamara technique is to write out questions and to insist on written answers. He maintains on his desk a black looseleaf notebook containing an annual list of over 100 questions on basic issues. Each February the questions identified by him and other line or staff executives are assigned to various advisers. The answers are due by the end of the summer, at which time they become the basis for changes in the five-year program budget.

Many of the questions require complex study. Consequently, McNamara assigns them to a unique study group, Dr. Enthoven's Systems Analysis Department. Dr. Enthoven has characterized the workings of the Pentagon technique as follows.

"It can best be described as a continuing dialogue between the policymaker and the systems analyst, in which the policymaker [McNamara] asks for alternative solutions to his problems, while the analyst attempts to clarify the conceptual framework in which the decisions must be made, to define alternative possible objectives and criteria, and to explore in as clear terms as possible (and quantitatively) the cost and effectiveness of alternative course of action." [4]

The DOD's civilian staff has been severely criticized by the military for its extensive utilization of computers in problem solving. But while he was Assistant Secretary, Hitch was particularly eloquent in supporting their use and in placing the computer applications in proper perspective. Parts of his argument can be summarized as follows:

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[3] *Missiles & Rockets*, March 1963, p. 30.
[4] "The Whizziest Kid," *Time*, June 28, 1963, p. 18.

Economic choice is a way of looking at problems, and it does not necessarily depend on the use of any specific analytical aids.

Computational devices are quite likely to be useful in analysis of complex problems, but there are many problems in which they have not proved particularly useful. In such cases, nevertheless, it is rewarding to array alternatives and think through their implications in terms of objectives and cost.

Where mathematical models and computations are useful, they are in no sense alternatives to, or rivals of, good intuitive judgment. They supplement and complement it.

Judgment is always of critical importance in designing the analysis, choosing the alternatives to be compared, and selecting the final course for action. The manager does not allow himself to become a slave to a certain investment cutoff level, for example, no matter how quantitatively exact its derivation may be.

Lesson #4: Systematic program analysis and planning can best be accomplished through use of logical, sequenced steps of approach.

This is an area where the DOD's efforts have been particularly fruitful for the businessman. A study of particular merit is the one conducted by Frank E. Gilmore and Richard G. Brandenberg in which they analyzed the thought process used by the Army Command and General Staff College in strategy formulation and constructed a network diagram for analogous corporate mission planning.[5] Their findings can be of considerable help in understanding the total planning process. The sequence of questions to be asked is as follows:

1. What are the challenges facing the corporation?
2. How do these challenges affect the enterprise's economic missions? For instance, what justification is there, to add a new product line?
3. What are the desired missions?
4. What are the attainable goals to be sought?
5. What are the competitive strategies to follow?
6. What action plans are necessary to implement these strategies?

This scheme resembles the problem-solving sequence for military situation appraisal outlined in *The Defense Department Staff Officers Field Manual.*[6]

Using these and other studies of the process of problem solving, we have developed a simple conceptualization of a generalized strategic planning methodology for business. This is portrayed in Exhibit IV. It has proved useful to IMC in a variety of ways.

Of particular importance is the "needs research" concept. How do executives think about the organization and its environment? Where does the definition of a problem or opportunity begin? Usually it begins with perceptual awareness of the organization's position or capability; this awareness, plus an imperfect knowledge of the environment, triggers the identification of a problem or opportunity. Preferably, relevant facts pertaining to the enterprise's position in the forecasted environment are then systematically gathered and analyzed to determine the agenda of problems and their relative priorities. This process may be termed "needs research" when conducted formally as in the Defense Department. The term "challenge" is perhaps more suitable than "needs," for it encompasses all the major strategic concerns: problems, needs, faults, threats, opportunties, and constraints to be circumvented. Such a formal inventory of needs or challenges also serves to stimulate creativity by exposing personnel to problems requiring solution.

Impact on organization

How has Lesson #4 affected the structure and broad responsibilities of IMC's Corporate Planning and Development Division? This is a sizable corporate-level staff division employing over 50 professionals of widely diverse skills. The duties of the several departments which compose it correspond closely to the main tasks mentioned in the planning model proposed in Exhibit IV:

Environment Analysis.—This department is staffed by people with market research and economics experience. Its tasks are to—

(1) Provide basic economic and market data.
(2) Provide industry and competitive "intelligence."
(3) Identify and measure new market needs, opportunities, and threats.

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[5] "Anatomy of Corporate Planning," HBR November–December 1962, p. 61.
[6] FM 101–5, 1960; see p. 142.

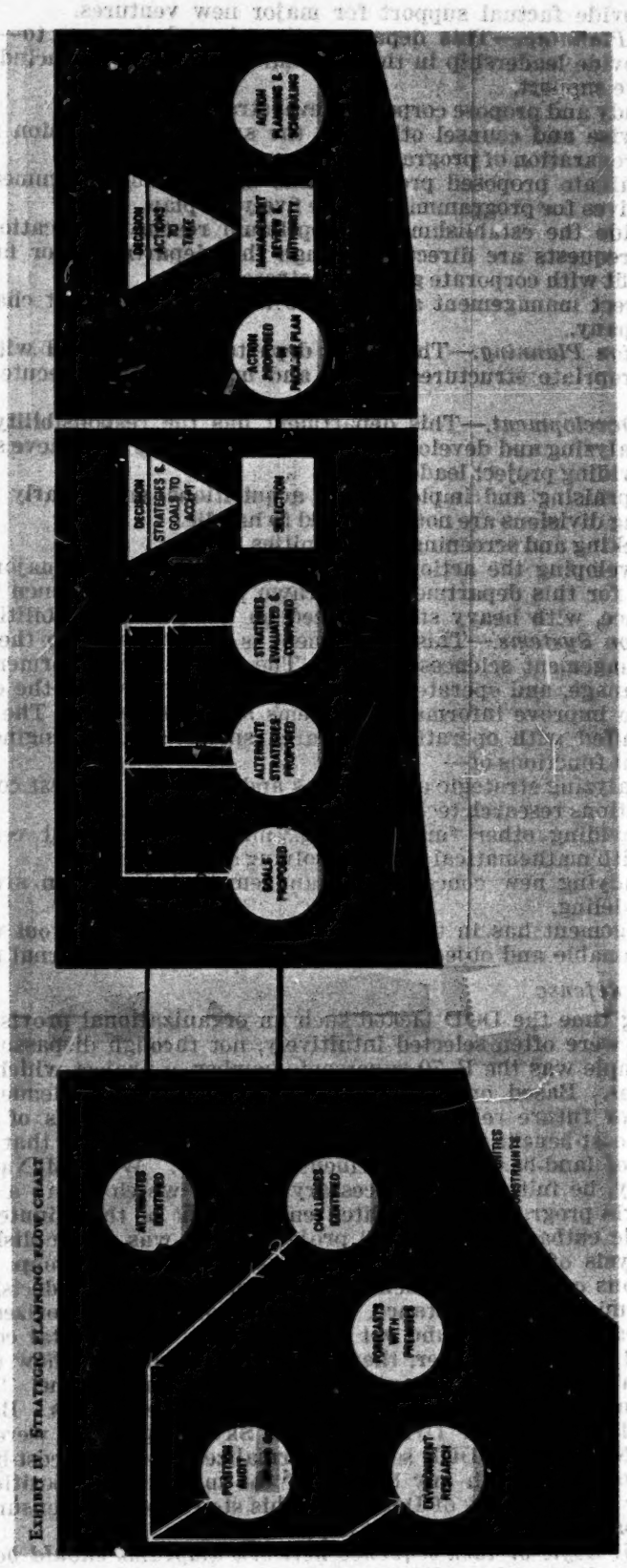

EXHIBIT IV. STRATEGIC PLANNING FLOW CHART

4. Provide factual support for major new ventures.

Strategic Planning.—This department's prime duties are to—

1. Provide leadership in the five-year plan assembly, including mobilizing executive support.
2. Study and propose corporate-level strategies.
3. Advise and counsel others in the synthesis of mission strategies and in the preparation of program packages.
4. Evaluate proposed programs and studies, and recommend cost-benefit alternatives for programming in the five-year plan.
5. Guide the establishment of optimum resource allocations (all major capital requests are directed through this department for final evaluation of their fit with corporate goals and strategy).
6. Direct management attention to the most important challenges facing the company.

Organization Planning.—This small department is charged with recommending the appropriate structures, skills, and manpower to execute the approved programs.

Venture Development.—This department has the responsibility for—

1. Analyzing and developing major new ventures to achieve strategic goals, and providing project leadership.
2. Appraising and implementing acquisitions, particularly those that the operating divisions are not organized to handle.
3. Seeking and screening opportunities.
4. Developing the action programming for approved major projects.

Personnel for this department are drawn primarily from men with engineering experience, with heavy stress placed on analytical capabilities.

Information Systems.—This department is subdivided into the data processing and management sciences groups. The duties of the former group are to program, manage, and operate data processing equipment at the corporate level as well as to improve information systems and procedures. The second group, which is staffed with operations research specialists and engineers, performs the important functions of—

1. Analyzing strategic alternatives and resolving the best course by means of operations research techniques.
2. Providing other functions, e.g., mine planning and venture development, with mathematical problem-solving skills.
3. Studying new concepts in management information systems, simulation, modeling.

Top management has in this division a decision-making tool whose purpose is to be reasonable and objective, free of prejudice from internal allegiances.

Progress in defense

For a long time the DOD lacked such an organizational provision. Strategic alternatives were often selected intuitively, not through dispassoinate analysis. A good example was the B–70 supersonic bomber, a project which made numerous headlines. Based on past experience, the Air Force leaders insisted on putting major future reliance on the B–70. But the Chiefs of Staff had not coordinated cost-benefit research of the B–70 capability with that of the Polaris missile and of land-based intercontinental missiles. When McNamara assumed responsibility, he initiated the necessary studies, which led to a sharply accelerated Polaris program, an expedited enlargement of the Minuteman program, and a drastic cutback in the B–70 project. This was accomplished through a detaile analysis of alternatives by the systems analysis group.

In numerous cases, the financial implications of program decisions were also poorly determined. For instance, the Chiefs of Staff authorized development of major weapons systems and yet had not projected the total cost of development beyond a year. Further, they had not predetermined how much it would cost to operate these weapons over an extended period of time. Too frequently a poorly conceived project consumed gigantic expenditures. Because of circumstances like these, the Dyna-Soar and Skybolt projects were cancelled.

Under McNamara, the DOD set up a formalized system of cost-benefit analysis by groups not allied with any branch of the military but positioned organizationally near the Secretary of Defense. This step has helped ensure that failures like Dyna-Soar and Skybolt will not happen again.

Lesson #5: Logic or task-sequence network diagrams should be used in planning, implementing, and monitoring complex projects.

One of the DOD techniques that has been most rapidly adopted by the business world is the use of logic networks in project planning. There are a multitude of variations under a variety of acronyms, but in general they hark back to PERT (Program Evaluation and Review Technique), CPM (Critical Path Method), and Gantt charts.

Although IMC is far from alone in the use of such networks for planning, a few examples of how they have been applied to great advantage should be instructive:

IMC is presently building a $60 million plant on the east coast of India as a joint venture with Standard Oil of California. In order to execute this project more efficiently in its early development phases, a task-sequence network was created for the general manager. Such tasks as securing approval from the Indian government for a license, hiring a sales manager, and conducting a market seeding program were predetermined for him in the necessary sequence and interrelationship.

At IMC's Saskatchewan potash mine, equipment was installed at the mine head which increased the hoist capacity from 1.5 million to 2 million tons per year with only 30 hours of downtime. This progress was made possible by a precisely scheduled construction program. PERT-like systems have been invaluable in similar close-down and start-up operations in many other areas as well, notably in steel mills and oil refineries.

DOD Application

As is well known, PERT was developed by the combined forces of the Navy Special Projects Office, Lockheed, and Booz, Allen and Hamilton. The application for which it was designed was the planning and control of what is familiarly known as the Polaris Project in 1958. Through the use of PERT, the efforts of many hundreds of contractors and many thousands of subcontractors were coordinated so effectively that the missile was operational two years ahead of the original schedule. Since then the transfer to business has been so complete that the application of the majority of PERT-like systems is now in nongovernment work.

In defense work, as in nondefense work, logic or task-sequence diagrams have offered several important benefits:

Implementational planning is ensured, for the network requires rigorous discipline in the evaluation of interrelationships between all project steps and imposes strict constraints on possible sequencing of events and actions.

Decision points that will strongly influence the direction and time span of a project are high-lighted.

Maximum allowable delays become clearly evident, as do the consequences of exceeding these delays.

The networks clearly define responsibility for each activity and also specify the activities with which a given operation must be coordinated.

Lesson #6: Decision-making centers are useful devices for expediting review or approval of programs in complex organizations.

A number of corporations have taken advantage of the decision-center concept. Du Pont is a well-known example of a company which has used it for both long- and short-range planning purposes. (Although Du Pont's design places heavy emphasis on control rather than planning, it also enables the implications of alternative future moves to be seen in overall perspective.) Du Pont's decision center is a room that makes use of a tramrail system and a hierarchy of charts which allows rapid pinpointing of operating problem areas.

The importance of visual-display techniques in increasing the effectiveness and efficiency of presentations cannot be overstressed. For instance, IMC has been able to justify extensive use of "visuals" to the degree that the Strategic Planning Department has its own graphic analyst and the corporation retains a consultant to increase the effectiveness of executive presentations.

The decision-center concept goes beyond the idea of a conference room as a place in which to argue proposals and make plans. Pertinent data about the corporation which may influence the advisability of alternatives can be made available quickly and in an explicit form. As more sophisticated information systems and document-retrieval techniques are developed, the power of centralized decision environment rooms will grow. In these rooms, executives will have at their fingertips historical and projected information from all phases of corporate activity readily retrievable from a computer data bank. Simulators of the corporate budget and major operations will be manipulated upon inquiry by the executives in conference. It will be the responsibility of a group such as the IMC Corporate Planning and Development Division to see that all possible queries are anticipated and available in a form which may be readily interpreted.

IMC has initiated tests of a computerized simulator for the five-year and one-year budgets. This approach yields several benefits, the two most obvious being (1) the ease of revising the five-year profit-and-loss budget projections periodically, and (2) the ability to compute the profit impact of a large number of alternatives. Management will be able to ask contingency-type "what if" questions during budget review, and to select a final one from a number of possibilities. This will help to overcome a key weakness—the fact that the final budget often results from negotiations between managers and their superiors, rather than from systematic evaluation and comparison of alternative uses of funds.

Facilities in DOD

When McNamara assumed command of the DOD, he felt that there was an excessive number of committee meetings and reports which tended to delay decisions on program changes. Consequently, a specially designed strategy decision room was created under the management of the Office of Programming, which is also in charge of maintaining the running five-year plan.

In this room are four "Vu-graph" type projectors that display against four adjacent screens. On one side of the room is a tramrail which brings forward on floor-to-ceiling charts the approved program-package data. On the opposite side, the tramrail displays added charts and data that relate to the specific elements under examination. Decision makers sit in the center area and can refer to the side panels for perspective. The visualization is flexible and provides needed support for the proposal or problem under examination. There is a computer located behind the projectors in the preparation area which also contains the charting and display requirements. DOD planners assert that they have the capability, if someone asks a question regarding trade-offs in resource allocation, to run the question through the computer, type the answer, prepare a visual, and project it back on the screen in seven minutes' time.

The military and NASA have created complex decisions centers using advanced electronic display equipment, but these facilities are designed for the deployment of *already allocated* resources. Decision environment rooms for resolving strategy questions have substantially different requirements. For instance, the information displayed is usually required on and ad hoc basis for single, not repeated, use in determining the best allocation of *new* resources.

CONCLUSION

If management is to exploit the rich resource of decision-making tools and techniques which have become available in recent years, it must do more than understand and appreciate these methodologies. Its commitment to the promise of such systems must be great enough to cause it to modify its organization and allow these concepts a position from which to operate. It must be willing to involve itself the way IMC did when it established the carefully structed Corporate Planning and Development Division and headed it with a vice president. In doing so, management says that it wants its past methods of decision making challenged, its proposals soundly evaluated by a disinterested team of specialists, its strategic moves made in the light of penetrating environment "intelligence," and its alternative courses of action systematically identified and weighed.

The cost of supporting the staff to carry out these tasks effectively is high, but it can be justified in a company committed to growth. Growth implies active change, and where change occurs rapidly, increased sensitivity is required to keep an organization's resources and capacities well matched to the opportunities most consistent with them. In an effort to continue building this sensitivity, management must strive to embrace and distill for its own use the multitude of consantly emerging advances in decision technology. A measure of uncertainty will always remain in business, but the prize will go to the one who plans and leaves the least to chance.

What can businessmen learn from the Department of Defense's pioneering work with management concepts? In this article the authors describe how one company, International Minerals & Chemical Corporation, has applied six "lessons" from DOD's experience:

1. Allocating the company's resources through use of the concept of strategic missions.
2. Annual budgeting integrated with long-range planning on a continuing basis.

3. Applying systems simulation and other O.R. techniques to complex strategy questions.
4. Program analysis and planning based on a logical, systematic sequence of analytical steps.
5. Use of task-sequence network diagrams in the programming and administration of complex development projects.
6. Decision-making centers for analyzing and reviewing corporate plans.

THE PLANNING-PROGRAMMING-BUDGETING SYSTEM: AN ANNOTATED BIBLIOGRAPHY

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INTRODUCTION

The increasing demand by the Congress and the Federal community-at-large for information on the Planning-Programing-Budgeting System (PPBS) has prompted the revision and expansion of the PPBS bibliography first printed in September 1966. The revision contains eight new annotated entries plus a listing of fifteen additional selections, which are not annotated. The bibliography briefly describes selected material covering PPBS concepts, implementing procedures and directives, and other selections assessing the impact of PPBS.

PPBS, a management system, was first introduced in the Department of Defense in the early 1960's. Conceptually, PPBS integrates planning, programming, and budgeting into an organization's decision-making process. Carefully articulated plans translate agency goals into specific objectives. Alternative methods of achieving these objectives are identified and programs are formed for each method. Program costs over several years are determined systematically, being drawn together from the planning, programming, and budgeting phases. Selected information and analyses are brought before the decision-maker who then judges the predicted performance of each program against its cost. Once in operation this process encourages a continuous appraisal of agency programs. Actual performance is compared against objectives that are being constantly revised.

Implicit in PPBS is the use of analytical tools. The first of these, "operations research," grew out of the research programs of World War II. Operations research became a valuable tool in the war to solve tactical problems, e.g., improving the effectiveness of anti-submarine and bombing operations. Systems engineering, cost-effectiveness analysis (or cost-benefit analysis), and the synthetic/analytic approach known as "systems analysis" were tools and techniques which closely followed the development of operations research.

Systems analysis and PPBS are closely related, but important distinctions can be made. Systems analysis usually is performed within a research environment while PPBS operates within a management environment. In a historical sense it could be said that the successes of systems analysis led to its adaptation in a series of management applications. Thus, a system of management was established that operates and is sustained by the use of the techniques and tools of systems analysis.

On August 25, 1965, President Johnson issued a statement expanding PPBS beyond the Department of Defense to selected civil agencies within the Federal government. This triggered a chain of events designed to spur and direct the implementation. Bureau of the Budget and agency directives have appeared, related Congressional hearings have been held, a number of essays and articles have been published.

On November 17, 1966, the President sent a memorandum to the heads of Departments and Agencies which emphasized the value of PPBS in achieving more effective and more efficient Federal programs. He noted that many agencies had been slow to establish PPBS. Accordingly, the Budget Director was asked to report to the President quarterly, beginning with the first quarter of calendar year 1967, on the progress of the implementation of his directive of August 25, 1965. In his "Quality of American Government" message to Congress, dated March 20, 1967, the President again stressed the worth of PPBS. The most

advanced techniques of modern business management would, he maintained, force the Federal government to ask fundamental questions that illuminate the choices. The President then underlined the need for more trained manpower and more data. He urged the Congress to approve the funds for PPBS requested in the budgets of the various Federal agencies.

This short, annotated bibliography selectively reflects the rapidly expanding literature on program budgeting and features the following categories of source materials:

(1) The basic concepts and development of PPBS;
(2) Bureau of the Budget and agency directives on PPBS;
(3) The operation of PPBS at the State, county, and city levels;
(4) An explanation of the analytical tools associated with PPBS;
(5) Congressional documentation on PPBS; and
(6) A summary of the Congressional interest in the systems approach.

I. Novick, David, *ed. Program Budgeting, Program Analysis and the Federal Budget* Cambridge, Harvard University Press, 1965. 382 p.

In the preface Novick emphasizes the need for program budgeting due to the complexities of resource allocation decisions. Program budgeting is designed to perfect or sharpen decision-making by improving the methods of framing problems and increasing the quantity, quality and organization of information available.

In view of limited resources, the central problem is to assure that a program's resource requirements can be reasonably met in the future as well as the present. While the allocation process is primarily a political one, new methods and techniques can illuminate the implications and ramifications of decisions to be made. Program budgeting provides such an approach.

The book is divided into three sections. Part I discusses the government's decision-making process and the role of budgeting in that process. Part II describes the development of the program budgeting techniques in the Department of Defense and presents possible approaches to other government functions. Part III deals with the implementation and operation of the program budget. The twelve articles and essays contained in the book are listed below. One or two sentence descriptions are included for eight of them; longer descriptions are provided for the other four.

Part I. Government Decison-Making and the Program Budget

1. Anshen, Melvin. "The Federal Budget as an Instrument for Management and Analysis." p. 3–23. The lead-off article is a summary of the actual budgetary process with associated problems and a potential program budgetary process with its strengths and weaknesses.

2. Smithies, Arthur. "Conceptual Framework for the Program Budget." p. 24–60. Smithies declares that society benefits in a direct proportion to the amount of information available on the implications of political decisions. He further believes that a government can determine its policies most effectively if it chooses rationally among alternative courses of action, with as full a knowledge as possible of the implications of those alternatives. He considers that planning, programming, and budgeting provides the necessary tools to do this. PPBS constitutes the process by which objectives, resources and their interrelations are taken into account to achieve a coherent and comprehensive program. Several factors increase the difficulties of program designing and include: (1) problem of highly complex or vague objectives; (2) possibility of a multi-agency program as opposed to a single agency program; (3) contradiction over functional versus some other method of programming, e.g., regional programming as the State Department might desire; (4) necessity for considering both public and private interests in programs aimed at economic development. Smithies suggests certain criteria that should be met when designing programs. The criteria should (1) permit comparison of alternative methods for carrying out the objectives; (2) consist of complementary components; (3) place service supplying elements of an organization in a separate program; (4) provide for overlapping structures in organizations where geographical and functional programs are required; (5) separate programs according to time span over which expenditures take effect. For example, functions may be divided into production, investment, and research and development.

3. Fisher, Gene H. "The Role of Cost-Utility Analysis in Program Budgeting." p. 61–80. Fisher divides program budgeting into three segments: (1) structural

aspects which are concerned with establishing a set of categories oriented primarily toward outputs; (2) the analytical process which requires using various analytic tools systematically; (3) information systems which will support the first two items. Fisher's primary concern is for one particular analytic approach of the second segment—cost utility analysis.

Part II. Actual and Potential Application of the Program Budget Idea

4. Novick, David. "The Department of Defense." p. 81–119. The author paints in the historical background to program budgeting by discussing its introduction in the Department of Defense.

5. Margolis, Milton A. *and* Stephen M. Barro. "The Space Program." p. 120–145. The applicability of the space program to program budgeting is discussed. The applicability of the space program to program budgeting is discussed. The present system orientation and a long planning horizon of the space program facilitate the budgetary changeover.

6. Meyer, John R. "Transportation in the Program Budget." p. 146–177. The Federal transport expenditures are grouped and discussed by function.

7. Hirsch, Werner Z. "Education in the Program Budget." p. 178–207. The article suggests more effective ways of dealing with the Federal support of education presently originating in 42 departments, agencies and bureaus.

8. Frankel, Marvin. "Federal Health Expenditures in a Program Budget." p. 208–247. The author outlines methods of program budgeting for health that will force to the surface answers on how much improved health is worth.

9. Hirsch, Werner Z. "Program Budget for Natural Resource Activities." p. 248–284. "There are many demands on Federal funds, and since we have limited natural resources that must be put to a variety of uses, the Federal government faced some difficult choices. Improved tools are needed to articulate these choices and to facilitate judicious decisions," the author declares.

He stresses the need for a carefully defined national resources policy. No such policy statement can be readily found, he says. Admittedly the quantity and diversity of public and private bodies involved in natural resources activities complicate the process of fashioning comprehensive and coherent natural resource programs. But the key question "Should less be devoted to A, more to B?" can be approached much more precisely.

The chapter is divided into four parts: (1) an examination of assumptions and objectives of our national resources policy; (2) a review of existing budget activity and suggested ways of bringing it closer to a program budget; (3) a presentation of how program budgeting can elucidate allocation decisions; (4) a consideration of administrative and institutional arrangements needed to implementation decisions.

Part III. Implementation and Operation

10. McKean, Roland N. *and* Melvin Anshen. "Limitations, Risks and Problems." p. 285–307. The problems that are likely to occur when program budgeting is introduced are dealt with by the authors. These problems fall into three broad categories—conceptual, operational and institutional. The very meaning of program budgeting will present difficulties. Is it (1) restructuring of the budget where costs are accumulated into more meaningful categories; (2) a budget that implies a longer planning horizon; (3) an adaptation of analytical tools, such as cost utility analysis and operation research, to the budgeting process; or (4) an arrangement for enforcing the allocation decisions?

Operational problems, those related to managerial implementation, could be of many sorts; (1) the difficulty of collecting and organizing the appropriate information; (2) the improper fit of the program budget into the budgetary process. The old budget structure will probably exist alongside the new for some time providing a potential for conflict between the two structures: (3) the centralization of authority by including a mechanism for enforcing central decisions. Decisionmaking could drift upward. Alternative solutions could be suppresed. Alternative studies could become "design studies;" (4) by increasing the rationality required in decision-making, a conservative bias might develop. Decision makers will be reluctant to take chances or rely on their institutions; (5) the lack of concern for uncertainties because they cannot be treated rationally. A procrustean approach to decision-making might occur.

Institutional problems are related to those pressures, bureaucratic or political, that are unavoidably present, in any organizational setting. To many of the

interests represented by the executive, legislative and private sectors, the program budget will be seen as a disturbance "if not an outright threat."

11. Steiner, George A. "Problems in Implementing Program Budgeting," p. 308–352. The broader problems arising from the implementation of program budgeting are discussed. The article addresses the question, "How fast and in what depth shall program budgeting be further used in the Federal government?" Included is a diagram of a system for comprehensive planning.

12. Anshen, Melvin. "The Program Budget in Operation." p. 353–370. The author discusses the implications of a fully implemented program budget. This is treated in a context of the potential, impact on Federal, state and local governments, and industry.

II. "Planning-Programming-Budgeting System: A Symposium," *Public Administration Review*, Vol. XXVI, No. 4, December 1966.

The December 1966 issue of the *Public Administration Review* features a symposium on the new management system which the civilian agencies of the Federal government have adopted recently. The series consists of six articles on the subject, three of which are annotated below; the remaining three are listed later.

1. Schick, Allen. "The Road to PPBS: The Stages of Budget Reform." pp. 243–258. The author examines and carefully weighs the question, How does the new budgeting system differ from the old? As a follow-up, he asks, What is the significance of this difference? Three distinct stages of budgetary reform are discussed in order to provide an historical perspective on the recent changes in the budgetary process, viz., the introduction of PPBS.

The concepts of control, management, and planning identify the three stages. The first stage dated roughly from 1920 to 1935 and emphasized the development of an adequate system of expenditure control. Although management and planning elements were present, the first priority was to establish a reliable system of expenditure accounts. The second stage with a management orientation emerged during the New Deal and culminated in the movement for performance budgeting. The third and present stage stresses integrating the planning and budgeting functions of government. PPBS was first developed and refined in the Department of Defense. Because of its success the President directed that it be adopted by all Federal civilian agencies.

The author admits that the two previous orientations—control and management—continue to influence the budgetary process and act as constraints on budget reform. Yet, PPBS is designed to alter the form in which information is categorized, affecting the actions of budget makers. Sytsems analysis and the cost-benefit approach is stressed. In this connection a new group of professionals are being brought into budgeting. They are committed to the "types of analysis and norms required by the new techniques" and have a "background in economics and systems analysis rather than in general administrative training."

2. Greenhouse, Samuel M. "The Planning-Programming-Budgeting System: Rationale, Language, and Idea-Relationships." p. 271–276. The author makes two points in this succinct article. First, a single concept forms the base of the PPBS structure.

"The PPBS concept is that each Federal Agency is accountable to the President for the production of goods and services, and more particularly, for the distribution of these goods, and services to the American people."

This is a departure, the author maintains, from the previous purpose of the budget system which was to provide the Presidency with administrative support.

Second, key terms, which are common in analytical and budgeting circles, have different meanings in the PPBS context. The author proceeds to define and explain eight terms that are vital elements of the new system. These are: objectives, programs, program alternatives, outputs, progress measurements, inputs, alternatives, and systems analysis.

3. Wildavsky, Aaron. "The Political Economy of Efficiency: Cost Benefit Analysis, Systems Analysis and Program Budgeting." p. 292–310. Systems Analysis, program budgeting and cost-effectiveness analysis involve a great deal more than economizing and efficiency. They can have far-reaching effects on the structure of a political system. The author argues these points and atempts to strengthen his position by identifying what the new techniques can and cannot do.

Wildavsky discusses the underlying economic and political assumpions of cost-benefit analysis. He covers the limitations and mixed benefits of this technique. Systems analysis is treated in a similar way. It is defined compared with other techniques, and evaluated. Finally, the character and the role of

program budgeting are assessed. How are programs conceived? How are ends separated from means? Answers to these and other questions are given.

In conclusion the author points out the imbalance created by the emphasis on economizing. The economic emphasis should not outweigh the concern for the political dimensions. This will happen "if political rationality continues to lack trained and adept defenders."

The other three articles not discussed here are:

4. Hirsch, Werner Z. "Toward Federal Program Budgeting." p. 259–270.
5. McGilvery, Francis E. "A Management Accounts Structure." p. 277–282.
6. Banks, Robert L. *and* Arnold Kotz. "The Program Budget and the Interest Rate for Public Investment." p. 283–291.

III. U.S. *Bureau of the Budget.* "Planning-Programming-Budgeting." Bulletin No. 66–3, October 12, 1965. 13 p.

The bulletin describes procedural steps for establishing and implementing the planning, programming and budgeting system. The background, concepts and structure of PPBS are discussed. Agency responsibility is spelled out in broad terms. A schedule is included requiring the agencies to submit multi-year programs and plans by May 1, 1966.

IV. U.S. *Bureau of the Budget.* "Planning-Programming-Budgeting." Supplement to Bulletin No. 66–3, February 21, 1966. p. 31.

The supplement describes the procedures for filling out and submitting two of the documents central to PPBS—Program and Financial Plan (PFP) and Program Memoranda (PM). The PFP is a tabulation of program outputs, in the form of services or hardware, and program inputs, in the form of costs and other financial data. The Program Memorandum is to be prepared annually on each of the program categories shown in the PFP. The PM provides the analytic backup to the individual program. These memoranda are to serve as basic planning documents. They are periodically updated on the basis of new information, shifting objectives, or changing availability of resources. Both documents are to be submitted for the first time by May 1, 1966 and will form the basis of the spring review of the budget.

V. *Office of Economic Opportunity.* "Establishing of the Planning-Programming-Budgeting System" OEO Instruction No. 72–2, July 16, 1966. 54 p.

The instruction establishes PPBS in the Office of Economic Opportunity and incorporates the requirements outlined in Bureau of the Budget Bulletin 66–3 and its supplement. It opens the way for implementing program budgeting procedures by supplying the essential background, assignments or responsibilities, definition of terms, and an explanation of procedures and reports. The report is divided into eight sections:

1. Introduction
2. Assignment of system responsibilities
3. System end products
4. The annual budget plan and the annual operating plan
5. Threshold change procedures
6. The program structure
7. The ideal PPBS cycle
8. Glossary of terms.

V. Mushkin, Selma J. *Planning, Programming, Budgeting for City, State, County Objectives.* State-Local Finances Project, George Washington University. 1967. 5 documents. p. 63.

The State-Local Finances Project of George Washington University, under the direction of Selma J. Mushkin, prepared a series of documents on the planning-programming-budgeting system for State and local governments. The first of the series introduces the concept by discussing the purpose, history, characteristics, and components of the new budgetary system. Exhibits have been used to illustrate a PPBS program structure and a multi-year program and financial plan.

The remaining four parts of the series address specific problems of integrating PPBS into a governmental organization. The explanations cover points in question from "why PPBS?" to the procedures of how to staff and train for PPBS.

The other four parts are:

1. PPBS Note 1—Is an integrated planning, programming, budgeting system useful for our jurisdiction?

2. PPBS Note 2—Administrative framework for establishing planning-programming-budgeting systems in states, cities and counties: some considerations are suggested possibilities.
3. PPBS Note 3—Development of initial instructions to inaugurate a planning-programming-budgeting system: some preliminary considerations and model instruction to be adapted for local use.
4. PPBS Note 4—Staffing and training for a PPB system in state and local governments.

VII. Wise, Harold F. "Planning, programming, budgeting systems and the planning role." *In* Extension of remarks of Honorable Hugh Scott. Congressional record. [Daily ed.] (Washington), v. 113, February 15, 1967. p. S1975–S1978.

The paper reviews the demands which are being placed on the planner and budgeteer today, and discusses the contribution which PPBS is making as it assists management in determining how, when and where to allocate precious resources. A brief discussion of the State and Local Finances Project, the so-called "5–5–5 Project," is followed by commentary on the difference between traditional urban planning and the PPBS "multi-year broad, functional-area program statement" for a period of one to five years.

Mr. Wise states that what is really needed is a combination of PPBS and "comprehensive (i.e., long range, all-inclusive) planning." A recommendation is made for a viable planning program which has four levels of output, considered in terms of detail, generality, time scale, and particularity. The four elements would be:

1. A Comprehensive Development Policies Plan (a broad statement of direction).
2. A series of functional plans, crossing program and often department lines, and developed at the State level.
3. A program plan for each program within the galaxy of activities of the affected level of government.
4. An annual development plan, where PPBS would be applied.

VIII. State of New York, Executive Department, Office of Planning Coordination, Division of the Budget. "Guidelines for integrated planning, programming, budgeting." 1966. 40 p.

The manual describes New York's planning-programming-budgeting system, and how the State departments may improve their long-range program projections. Procedures vital to the annual preparation of the budget have been modified to:

1. Include activities specifically geared to the preparation of long-range program projections;
2. Provide a transitional period for evaluation and coordination of long-range program projections, and to relate projections to comprehensive statewide goals and objectives; and
3. Prepare annual budget requests against a comprehensive projection of long-range needs.

The necessity for utilizing uniform formats in departmental program projections is stressed, and detailed guidance provided. Departmental needs and demands are examined with special planning forms depicted. Similar guidance is set forth for handling capital facility requirements, personnel requirements, fiscal requirements, and program research.

Graphic presentation to highlight and summarize key statistical information is encouraged, and numerous examples are provided. Recognition is given to the importance of developing top-level executive commitment to the planning process in each State department. Throughout the manual, emphasis is placed on concise, lucid instructions and examples, thereby heightening its value to the user.

IX. Grosse, Robert N. "An Introduction to Cost-Effectiveness." Research Analysis Corporation. AD 622112. July 1965. 27 p.

The paper introduces the reader to the basic theory, techniques and terms of cost-effectiveness analysis. The analytical techniques which comprise an important part of program budgeting are described as a systematic examination of the costs, effectiveness and risks of alternatives, policies, strategies or courses of action. The primary ingredients of the cost-effectiveness approach are:

1. Objectives
2. Alternatives
3. Costs of alternatives

4. Mathematical models relating each alternative to the stated objective
5. Criteria for choosing the alternatives

The remainder of the paper—a series of graphs—depict, step-by-step, the process of identifying and selecting alternatives in order to achieve a certain objective. From a simple manpower versus machine output problem, the author advances to the question of the performance effectiveness of military weapons systems.

X. U.S. *Congress. Senate. Special Subcommittee on the Utilization of Scientific Manpower* of the Committee on Labor and Public Welfare, "Scientific Manpower Utilization, 1965–1966." Hearings before the Special Subcommittee on the Utilization of Scientific Manpower. 89th Cong., 1st and 2nd Sessions, November 19, 1965, May 17 and 18, 1966. Washington, D.C., U.S. Govt. Print. Off., 1967. 213 p.

During the 89th Congress the Subcommittee held two sets of hearings on systems analysis and PPBS in connection with S. 2662, "The Scientific Manpower Utilization Act of 1965." The first set of hearings was held in California, at which time the Subcommittee received testimony on the State's experience with the four systems studies contracted out to local aerospace industries. Representatives of the State, including former Governor Pat Brown, and of the aerospace industry explained the character and scope of the studies on transportation, waste management, crime and information systems.

The second set of hearings focused on the Federal government and the progress of the extension of PPBS beyond the Department of Defense to the Federal civil agencies. The testifying witnesses were Alain Enthoven, Assistant Secretary of Defense for Systems Analysis; Henry S. Rowen, Assistant Director, Bureau of the Budget; and the agency officials responsible for PPBS in the Department of Health, Education and Welfare (HEW); Department of Housing and Urban Development (HUD); and the Office of Economic Opportunity (OEO).

Enthoven outlined the past experience of the Department of Defense with systems analysis. Describing systems analysis as "quantified common sense," he gave examples of its use and discussed the organizational arrangement necessary for optimum results. He identified the limitations of systems analysis, but emphasized that they usually were overstated. Enthoven concluded by commenting on the application of systems analysis to problems at the State and local levels.

Rowen, in his testimony, discussed the domestic agencies which, at that time, were in most cases just beginning to apply systems analysis and program budgeting techniques. PPBS was portrayed as a management system internal to the Executive Branch. Interlacing the system were certain analytical tools, crucial to its success; surrounding it were the problems and opportunities of implementation.

The remainder of the hearings was devoted to the present and future status of PPBS in HEW, HUD and OEO. Several difficulties in effecting PPBS within each agency were noted. The widely divergent goals of HEW would present a number of obstacles before a department-wire system could function smoothly. The recency of reorganization in the case of HUD would lengthen the changeover time. In a similar way the newness of the poverty program, administered and directed by OEO, in effect has constrained planning due to the limitations and inadequacy of past statistics.

A second document on two subsequent sets of hearings (held in January and March 1967) which also were devoted to the systems approach will be published in the spring of 1967 by the Subcommittee.

XI. U.S. *Congress. House. Subcommittee on Research and Technical Programs* of the Committee on Government Operations. "Federal Research and Development Programs: The Decision-making Process." Report of the Subcommittee on Research and Technical Programs. 89th Cong., 2nd Sess., June 27, 1966. Washington, U.S. Govt. Print. Off., 1966. 41 p.

The report, released in June 1966, by the Reuss Subcommittee on Research and Technical Programs, focuses on the Federal decision-making process and the achievement of national goals. Three aggressive Federal research and development programs—defense, space and atomic energy—are compared with three less aggressive programs: transportation, housing and facilities, and water pollution control. Three elements of dynamic decision-making are singled out:

1. Far-sighted decision-makers and far-reaching decisions;

2. The deliberate search for new ideas and new technology; and
3. Use of systems analysis and systems engineering to handle complex research and development problems.

In the case of *less* aggressive decision-making, three salient factors are identified:

1. Too little initiative by some program directors;
2. Inadequate Executive Office initiatives to remedy weaknesses at program level; and
3. Insufficient cost-benefit comparisions made by Executive Office of competing claims to Federal R & D funds.

The report supports PPBS, with its search for alternative objectives to meet national goals, alternative ways to attain these objectives, and with its reliance on cost-benefit analysis when selecting a particular alternative. In this context the report recommends an intensification of program budgeting efforts in the research and development programs of the Federal government.

XII. US. *Congress. Joint Committee on the Organization of the Congress.* Hearings before the Joint Committee on the Organization of the Congress. 89th Cong., 1st Sess. Washington, D.C., U.S. Govt. Print. Off., 1965. Part 12. p. 1775–1783. [Statement by Charles L. Schultze, Director, Bureau of the Budget.]

In his statement before the Joint Committee, Schultze poses several questions concerning Congressional action on the budget: (1) do appropriations committees have available the information important to matters of "program choices," (2) can greater consistency be achieved between various appropriations bills in view of the increasing number of multi-agency programs; (3) can Congress maintain harmony among its committees without burdening the Executive Branch with an annually expiring or biennially expiring authorization system?

In connection with those questions Schultze outlines the present efforts of the Executive Branch toward extending the Planning-Programming-Budgeting System into each department and agency. The purpose of PPBS is "to have a system which will provide the kind of specific information and analysis on the basis of which both Congress and the Executive can make better choices of where and how to allocate budgetary resources." The four elements of the system are: (1) definition of program objectives; (2) development of indicators or measures of effectiveness; (3) comparison of alternative ways; (4) placement of these three elements into a proper framework.

XIII. Chartrand, Robert I. "The systems approach: a tool for the Congress." *In* Extension of remarks of Honorable Hugh Scott. Congressional record. [Daily ed.] (Washington), v. 113, March 20, 1967. p. S4049–S4053.

The study describes the contemporary Congressional milieu, with its numerous and increasing demands upon the Members of Congress. Emphasis is placed upon examining how the "systems approach" might aid the Congressman both in his legislative and office-keeping roles, and also how the new tools and techniques culd be utilized in coping with problems in the public domain, such as pollution control, transportation planning, etc.

Possible applications of automatic data processing and systems analysis to Congressional problems in the lawmaking and appropriations areas of activity are set forth, and the possible impact of PPBS on the relationship between the Executive and Legislative Branches is noted. Current legislative activity involving the projected establishment of an ADP facility to support the Congress, and the adaptation of defense-and space-derived systems techniques to other priority problem areas in society, is delineated.

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14. Hatry, Harry P. *and* John F. Cotton. Program planning for state, county, city. State-Local Finances Project. George Washington University. 1967: 72 p.

[From Harvard Business Review, March/April 1967]

Private Responsibility for Public Management

(By F. Bradford Morse)

Author's Note.—I wish to thank Linda K. Lee, my administrative assistant, and Robert L. Chartrand, of the Science Policy Division, Legislative Reference Service, Library of Congress, for their invaluable help in preparing this article.

There is widespread agreement that despite the expenditure of billions of dollars and the proliferation of public programs and services, we are still a very long way from solving our nation's social and economic problems. It is increasingly evident that the fault lies not in congressional niggardliness or administrative inefficiency, but in the traditional approach to public problem solving.
pollution control, to name just a few, we are still operating on the old project-by-

In our federal programs for urban renewal, transportation improvement, and pollution control, to name just a few, we are still operating on the old project-by-project basis. Problems are subdivided into manageable units, but rarely are those units coordinated into a comprehensive pattern. It is rarer still for one program to be related to another, particularly in a case where agency jurisdictional lines do not overlap. To cite just three instances:

One agency may be building roads to bring more cars into the city, while another agency is developing mass transit systems to keep them out.

Recently the Federal Aviation Agency awarded money for modernization of an airport in Massachusetts, while the Civil Aeronautics Board was denying certification of the only commercial flights into the city served by the airport.

When the bill to create the Department of Housing and Urban Development was before Congress in 1965, it was being touted as the coordinating unit for all urban programs. In reality it was to have jurisdiction over only a handful of the more than scores of federal programs then in existence.

There is no lack of criticism of this haphazard approach to major national problems. Nevertheless, when the gains made in coping with our environmental problems are stacked up against the exciting breakthroughs that have been made in our aerospace efforts, it is clear that we are improving the quality of human existence here on earth at too slow a rate.

The incapacity of government, as presently structured, to make notable progress in achieving national goals of clean air and water, livable cities, and educational excellence weakens the confidence of the business community that the taxes it pays are producing proportionate results; and—more important—it disappoints the expectations of those who have been promised a better life.

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* Annotated version appeared in first edition of SP 114.

A NEW APPROACH

In my judgment, we are on the threshold of an entirely new approach to the solution of these public problems. It will involve an altered relationship between business and government. It will mean changes in the governmental structure at all levels to accommodate multidisciplinary programs. To accomplish this revolution, there is increasing interest in turning to the companies that have developed effective management tools for the space and defense fields and using these techniques for the solution of nondefense problems.

What I am talking about, of course, is systems management. There are about as many definitions of systems management as there are systems managers. Former Department of Defense Comptroller Charles J. Hitch used this characterization in referring to U.S. military objectives:

"Systems analysis at the national level . . . involves a continuous cycle of defining military objectives, designing alternative systems to achieve these objectives, evaluating these alternatives in terms of their effectiveness and cost, questioning the objectives and other assumptions underlying the analysis, opening new alternatives, and establishing new military objectives." [1]

This definition is a good one for broad application when the word "military" is deleted.

Systems management is sometimes regarded by the uninitiated as nothing more than the application of automatic data processing. Computers, like cost effectiveness analysis and specialized accounting techniques, are merely tools of the systems manager; they increase his capacity to make good decisions by improving the quality and the quantity of his information.

The amount and quality of available information are critical to the success of public programs. Far too often, however, decisions are made with inadequte data, usually because not all of the necessary factors were taken into consideration. As one local government official described the public management process, "We manage by reaction rather than design." Use of the array of tools available to the systems manager can immeasurably improve the quality of public decision making, and hence the quality of public programs.

Faced with the problems of a society characterized by a rapid growth rate, increasing complexity, and high mobility, the nondefense public agencies in many ways stand today in a position comparable to that of the military establishment in the early 1940's. At that point, technology had outstripped management. For instance, the military discovered painfully that airplanes could not be designed and built in pieces. The sophisticated aircraft required had to be the product of a variety of disciplines, ordered into a comprehensive design and plan of production.

The tremendous gains in management science that were triggered by the war and the postwar period were a tribute to the inventiveness and skill of U.S. industry. Now we must bring that skill to bear on the nonmilitary aspects of our national life. Although the United States is a wealthy nation, its resources are not unlimited, and our decision makers must assess carefully where to expend them in the face of a rising population and its complex problems. The systems approach, combining logic and the techniques of acquiring, organizing, and analyzing key information, is critically needed.

Of the millions the federal government is spending on research, only about 10% is going into the nondefense sector. We still know very little about the control of pollution, the possibility of eliminating urban blight through the use of new building materials and designs, or the relationship between transportation patterns and economic growth. And, to be sure, we know relatively little about how to apply the management skills we have to these "soft" problems.

Necessary start

It was for this reason that, in the current session of Congress, I again introduced legislation to create a National Commission on Public Management. The proposed commission would be a working one and would include representatives of government, industry, labor, and the academic community. Its mandate would be two fold: (1) to collect and analyze information about the application of systems techniques to nondefense, nonspace, public problems, and (2) to develop programs which would use these techniques to solve specific problems. One of its principal responsibilities would be to consider appropriate financial arrange-

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[1] "Plans, Programs and Budgets in the Department of Defense," *Operations Research*, January–February 1963, p. 8.

ments for the use of private management capability. At this point, it is a question whether contracts, loans, tax incentives, matching grants, or some combination of these would be the most effective approach.

There is already considerable interest and some experience in this approach at all levels of government. The introduction of the Planning-Programming-Budgeting System (PPBS) in the Executive Branch is a step toward more comprehensive governmental planning. Use of PPBS in each agency is intended to produce a "comprehensive multi-year program and financial plan, systematically updated; analyses, including program memoranda, prepared annually and used in the budget preview; special studies in depth from time to time, and other information which will contribute to the annual budget process." [2]

And Vice President Humphrey has commented on the ability of systems techniques to help achieve the goals of the Great Society:

"I have been convinced for many years that such urgent public problems as environmental pollution, inadequate education, economic underdevelopment, congested transportation, and inferior medical care can be resolved more effectively by systematically bringing our best scientific and engineering resources to bear on them. The defense and space programs have taught us how to mobilize these talents to achieve gigantic goals and we can now use what we have learned to help realize the Great Society." [3]

Public efforts in this direction are not limited to domestic problem solving; the Agency for International Development is moving in this direction as well. An interagency task force recommended in November 1966 that U.S. industry be given management responsibility to carry out development programs in the less developed countries. In particular, it recommended starting a pilot program to test the systems approach in planning and operating development programs, with emphasis on the war on hunger. Heading the project would be consortia of U.S. companies which, when working together, would have the capability to use the systems approach. One of the key problems here would be convincing the governments of the less developed countries to use such management contracts for development with AID financing.

Some firms have already ventured into the economic development sphere. Among them are Litton Industries, Inc. and Lockheed Aircraft Corporation:

Litton prepared a program for the Greek government to develop Crete and the western Peloponnesus using the systems approach. The plan was for Litton to provide the management capability for a 10-year project with twin goals—transforming both regions into tourist attractions and stimulating industrialization.

Lockheed has looked into education planning in the Dominican Republic. Starting from the inarguable premise that education, manpower, and capital investment are key elements of economic development, Lockheed prepared an economic model for the Dominican Republic, emphasizing the changes in gross national product that could result from various approaches to a national education system. Using systems analysis, the aerospace firm tested various combinations of educational, motivational, and health factors, technological requirements, and labor requirements. The result will be an educational and vocational training package designed ultimately to stimulate additional capital investment in a country with an improved labor force.

CALIFORNIA MOVES AHEAD

As exciting as these possibilities are, however, the difficulties for systems managers of making the transition from precise requirements to essentially less quantifiable social needs should not be minimized. This is one of the lessons to be learned from the widely reported California contracts. In 1965, the state took a bold step forward in hiring four aerospace firms to undertake "systems engineering" studies in four areas: transportion, crime prevention, data handling, and waste management.

With California's rapidly growing population and heavy dependence on government contracts in space and defense applications, officials there felt that the expertise on hand could be used to good purpose. The aerospace firms, long interested in diversifying, were willing to invest substantial sums to identify areas for

[2] "Planning-Programming-Budgeting." Bulletin No. 66-3 of the Bureau of the Budget. Executive Office of the President. October 12, 1965.

[3] Letter to Carl F. Stover, President, National Institute of Public Affairs, included in an address by Stover, "The California Experiment—An Appraisal," delivered before a meeting of the Electronic Industries Association, San Francisco, October 19, 1966.

future work. Each firm was awarded a $100,000 contract, but much more was invested as the state and the companies looked hopefully at the lessons to be learned and the applications to be developed for the future. Here are summaries of the studies.

Transportation

Guided by criteria prepared by the State Division of Highways, North American Aviation, Inc. drew up seven tasks which could utilize systems processes:

1. Definition of the state's transportation system and identification of interrelationships affecting it.
2. Appraisal of the state of the art in transportation and areas impinging on it; projection of their development 30 to 50 years ahead.
3. Identification of existing key data; delineation of acquisition procedures; and determination of data selection procedures.
4. Investgation as to whether current methodologies will apply to analysis of the newly formed data base.
5. Creation of a "blueprint" for use in the analytical phase, featuring progressive flow, interelement relationships, and developmental trade-offs.
6. Development of a straightforward model to test the blueprint.
7. Determination of the management, performance, cost, and phasing aspects of the analytical stage.

Crime prevention

Space-General Corporation and its subcontractor, Serendipity Associates, successfully proposed to state officials that California concentrate its efforts on the prevention of crime and delinquency, with emphasis on their social and economic causes. Space-General proposed five tasks, including establishment of new statistical descriptions of crime and criminals and new concepts of crime cost, and the use of computer models and analyses to reflect behavior patterns and projected system costs.

Data handling

Lockheed Missiles and Space Company devoted itself to a review of the objectives and requirements for information. The three tasks that it established were:

1. Analysis of the current and projected requirements and objectives of 18 functional areas, including all state agencies, some local governments, and private groups.
2. Design of an information handling system for the state, including cost-performance considerations and alternative configurations.
3. Preparation of a time-phased implementation plan.

Waste management

This study, awarded to the Aerojet-General Corporation, was visualized by the state in terms of 8 tasks, but the contratcor divided them into a 12-task set. The spectrum of studies included establishment of selection criteria for a projected coordinating agency, a data handling system, and recommendations for future research, development, and construction.

The monitoring of these four studies was assigned to Systems Development Corporation, since the state did not have resident capability to evaluate them. The significance of this action must not be overlooked, for here is a good example of necessary government-business cooperation.

The California studies demonstrated that the systems approach is potentially feasible for attacking public problems. An evaluation by the State Department of Finance, however, suggested that the techniques were not automatically transferable without modifications and a learning process by both sides of the government-industry partnership. One of the difficulties encountered, and one I hope that the National Commission which I have proposed would consider very seriously, is that of communication between systems engineers with a military hardware orientation and the social scientists and politicians with responsibilities and experience in the nondefense sector.

PROGRESS ELSEWHERE

While the California experiment is the boldest yet undertaken, a number of other governmental units are also turning to private management. The State of New York is working with Systems Development Corporation on the design and development of a computer-based criminal identification and intelligence

system for the state. The information file is expected to approach several billion characters and will be available to state and local police, courts, and correctional institutions.

At the same time, the New York City Police Department is working on a systems design to speed communication and improve its day-to-day operation, and Mayor Lindsay's administration is actively seeking opportunities for systems techniques in city government.

One of the most exciting efforts to substitute planning for reaction in public decision making was the systems analysis applied to San Francisco's urban renewal program. This was described at length in HBR last fall,[4] and I mention it here only because it is a splendid example of the use of systems analysis to increase the information and alternatives available to the policy maker so that the resulting programs will be more appropriate to the needs of the area and more relevant to its entire environment.

State and local governments have clearly led the way in forging government-industry partnerships, but there are signs of awakening interest in Congress, apart from the wide sponsorship of the Public Management bill. The Demonstration Cities and the Clean Rivers Restoration Acts of 1966 both provided incentives for comprehensive programs encompassing all affected communities and problem areas.

As a result of the passage of the Clean Rivers bill, interstate action has been launched to develop the cleanup of the Merrimack River in New England, one of the most polluted streams in the nation, through the use of systems analysis. Businesses in the area have come forward with new techniques of pollution control, and there is widespread interest in attacking the river pollution problem as a total "system," not merely in terms of its impact on each community. Approaches of this kind suggest new dimensions of regionalism, since the majority of our public problems are of an interstate character.

CASE OF TRANSPORTATION

Certainly this is true of transportation, which has already been the subject of systems analysis at both the research and the operational level. Actually, the use of modern management practices is not new to transportation. As long age as 1925, the State of Michigan instituted a 45-column punch card system for the constant inventory and rapid maintenance of roads and bridges and the evaluation of contract performance. Highway benefit-cost analysis has been going on about 15 years. Nonetheless, transportation still remains a good example of a public problem which is basically being attacked with "micro" approaches, rather than a "macro" approach that takes into account the interrelationships of all the factors involved.

A May 1965 report to the Secretary of Commerce said that more than 30 federal agencies, including no fewer than 8 under the Secretary's jurisdiction, were conducting, or had contracted for, research in transportation. "So far as we have been able to determine," the report said, "these programs are largely uncoordinated and carried on independently of each other."[5]

Although the new Department of Transportation presumably will try to end most of this fragmentation of effort, I am convinced that the bureaucratic solution of a new federal coordinating agency is not enough.

For example, planners know that the location of highways influences the growth of adjacent land, and that land use generates traffic, but how often do they consider the total environment of a metropolitan area, present and future, before attempting to determine what network of ground, air, and even underground and water transportation would best suit that area?

More experts in and out of government are inclining toward a view expressed a few years ago concerning highway plans for the District of Columbia. Two observers insisted that a transport network must be evaluated in terms other than merely meeting existing or future demand, since the system itself will contribute to shaping future demands. The most important thing to consider, they maintained, is the long-run developmental goals for the area which the

[4] Cyril C. Herrmann, "Systems Approach to City Planning," HBR September–October 1966, p. 71.

[5] Report of the Panel on Transportation Research and Development of the Commerce Technical Advisory Board to the Secretary of Commerce, p. 78.

system will serve. Then and only then can the contribution of a transport system to the area to be evaluated.[6]

Robert A. Nelson, manager of the Northeast Corridor transportation project of the new department, not long ago stressed the idea of first determining what we want our cities to be:

"Up to now the public has expressed a desire to live in the suburbs and work in the downtown areas. But it may be that the best approach to the reduction of urban congestion is to encourage a proximity of work and residence. This has occurred already in some metropolitan areas as industry has followed population to the suburbs. On the other hand, social considerations, rather than economic, may dictate the result to be influenced by transportation.

"In any case, we need to ask how we intend to use the centers of metropolitan areas in the years to come. Will they be places of work only or will they be residential? What kind of work will be carried on in the centers of major metropolitan areas? Will it be institutional, government, finance, insurance, the front offices of large corporations, as seems to be increasingly the case? Or will educational and other institutions tend to locate in the central city, making it a cultural and entertainment center with museums, exhibits, hotels, convention halls, and theatres?

"These are all questions fundamental to the planning of transportation facilities for the future."[7]

Despite Nelson's vision, it is unlikely that the new department can be expected to take all these factors into account.

Both the federal government and private corporations have been devoting increased effort during the past few years to the transportation problems of the Northeast Corridor, the megalopolis extending from north of Boston to south of Washington, D.C. Some 37 million people, nearly 20% of the nation's total population, inhabit this area, which comprises scarcely 2% of the nation's total land area. This 400-mile stretch of land is expected to be home for some 64 million urban and suburban dwellers by the year 2000.

Some studies have stressed the need to take into account the relationship between transportation networks and other economic and social needs. A report on building a high-speed transit system, prepared at M.I.T. for the Commerce Department, pointed out how the very location of passenger stations can affect economic and social disparities in the community. At minimum, transportation changes should not aggravate social tensions. At best, transportation planning can be a creative aspect of overall environmental improvement. It is obvious that a sensitive multidisciplinary approach is necessary.

No time to lose

It is not too late to decide what should be the environment of the Northeast Corridor, of which its urban and interurban transit network will be just one facet. It is not enough to wait until 2000 to see where the extra 27 million people have gone so that the most efficient system to carry them to and from work, school, shopping centers, and recreation areas, to near and distant points—not to mention supplying them with goods—can be devised. And clearly it is not too early to begin thinking about the future environment of such budding megalopolises as the West Coast, the Gulf Coast, and the growing urban centers of the Midwest.

The federal government already has launched projects that give promise of coming up with answers to some of the important questions. One of the most ambitious is a three-year, $90-million, high-speed ground transportation research and development program authorized by Congress in 1965.

The Department of Transportation is working on three separate projects. The first, under contract with the Pennsylvania Railroad, is designed to improve passenger service between New York and Washington. Extensive sample surveys of passengers and nontravelers as well have been undertaken with the use of automatic data processing equipment. Among other things, the data are being used to project the economic impact of improved rail service in the area. Among the new services proposed is a suburban station with extensive parking facilities at the junction of the Pennsylvania roadbed and the Beltway that circles the nation's capital. It is expected that by late 1967 the new service will be fully

[6] Lowdon Wingo, Jr. and Harvey S. Perloff, *The Washington Transportation Plan: Technics or Politics* (Washington, Resources for the Future, Inc., 1962), p. 5.
[7] Remarks delivered at Case Institute of Technology, Cleveland, Ohio, October 1965.

operable, using the best of existing self-driven electrical equipment to reduce the travel time to two hours and 50 minutes.

For the Boston-New York run, however, the department is leasing two new gas turbine engines specially designed by the United Aircraft Corporation to take curves more quickly on the existing road bed. If the experiment, which is expected to begin after July 1, 1967, proves successful, the department hopes to end its lease and have the equipment purchased by the New Haven Railroad.

The third, and probably most ambitious, project is still in the design stage. This is the proposed auto-train service between Washington, D.C., and Jacksonville, Florida. The project is designed to accommodate those who want their car at both ends of the trip but would prefer not to make the long, boring drive. Marketing studies have revealed sufficient interest to make the project economically feasible, and work is going forward on the production of a prototype vehicle. Present plans call for ten double-decked railroad cars, each of which would hold eight automobiles. Also, two service cars would provide food and lounge service and play areas for children. This totally new type of transportation has obvious implications for future highway safety and construction needs.

But even when the technical questions involved in these and other projects are answered, the projects must be avaluated not only against the social and economic considerations to which Nelson referred, but also against other possible forms of interurban transport, such as vertical takeoff and landing aircraft (VTOL's).

The number of factors to be considered in devising a transportation scheme is bewildering. It is questionable whether current efforts are coming to grips with all of the following considerations (and these are just a sample of the many issues, major and minor):

With urban land values skyrocketing and the possibility of developing cheaper methods of tunneling, it may be economically feasible to build high-speed underground highways controlled by closed-circuit television and connected to multilevel, below-surface garages at certain points.

Since the time spent going to and from airports often exceeds the time spent in the air, faster transport to air terminals is a necessity. Should it be over, under, or on the ground?

It is a fact that in large metropolitan areas like New York and Chicago, motor vehicle ownership is much lower than the national average. What consideration should the planners give to this situation?

How would changes in fares affect riding habits in an urban rapid transit system?

What would be the best method to connect passengers with supersonic aircraft destined for distant points? For instance, an SST flight originating in Los Angeles might be serviced by rapid transit from Pasadena, and by short-haul aircraft from Las Vegas.

Automatic operation of automobiles on the highway (with operation by their drivers in the city) may be a feasible method of controlling high-speed traffic.

How can smaller commercial and private airplanes be separated at the airport from the large, high-performance aircraft, while maintaining accessibility for all types of aircraft?

California's contract with North American Aviation is one instance of the use of systems analysis in transportation. Here are some other investigations that are under way.

Stanford University's Institute in Engineering-Economic Systems has developed a mathematical model to aid northeast Brazil in making intelligent decisions about its transportation priorities. The model includes a regional analysis of the key factors involved in the investment decision—food demands; current and projected consumption and production statistics; nutrition and diet; relative costs of transport by truck, rail, and water; and alternate routes and interchanges for various commodities.

More important in some respects than the Institute's conclusion that the region's top priority should be the construction of new farm-to-market roads is the information acquired from the model for use in related projects of agricultural planning, foreign exchange needs, and nutritional supplements. In addition, the model has wider applicability, as a report of the Institute states:

"The more fundamental benefit of systems analysis is the development of techniques of wide applicability, in addition to that of answering questions in specific

countries. Therefore, the present model is defined at a level of abstraction which allows application to transportation in other geographic regions. Whether these applications can be made easily depends on the state of data collection in the region of application, although the data required are not extensive, compared with planning models in general."[8]

The Tri-State Transportation Committee, composed of representatives of New York, New Jersey, Connecticut, New York City, and three federal agencies, has assembled over the years a vast data bank. Using the data, the group sets up models simulating future land development, travel patterns, and loads on highway and mass transit facilities. The models help in evaluating alternative transportation networks for the area.

Under contract with the federal government, the Texas Transportation Institute and the Raytheon Company are evaluating the traffic control system on the John C. Lodge Freeway in Detroit, and recommending ways to improve it. This is a good example of pooling of resources which often permits more effective work than is possible in a government or single-enterprise operation. TTI, an arm of the Texas A&M University, is skilled in traffic theory and analysis and traffic control and operation; Raytheon is experienced in systems engineering and evaluation, providing ground instrumentation, and electronic surveillance, command, and control systems. This use of consortia for public problem solving, also advocated by the AID task force mentioned earlier, is a technique that should be more fully explored.

The Skylounge project in Los Angeles is an interesting illustration of an effort to interrelate various modes of transportation. No fewer than six companies are taking part in the experiment sponsored by the City of Los Angeles Airports, with financial assistance from two federal agencies. The project is working with "pods" having a capacity of 40 or more passengers, that are picked up at collection points by helicopter and flown to the airport. Under their own power the pods collect and distribute passengers at each end of the flight.

These and other projects, such as the Bay Area Transportation Study in San Francisco, indicate the extent to which new management tools can increase our capacity for analysis and planning despite limitations of time, manpower, and money. They also suggest something of the variety of tools and types of management organization that can be brought to bear on our public problems.

CALL TO ACTION

This ferment of activity can be found in other areas, such as pollution control, waste management, education, and health services. But we should not make the mistake of assuming that all of the studies and experiments will be productive or that they will receive the kind of attention they deserve. There is still a considerable gap between the concern and enthusiasm of those actively pursuing systems analysis solutions to public problems and that of the highest national policy makers. This makes it imperative, in my judgment, to push the Public Management bill and related legislation.

It would be a mistake for us to put more and more public funds into programs that are inherently incapable of achieving their stated goals. Whatever the present limitations of our knowledge and experience in systems analysis for the nondefense sector, I think we must make a major national commitment to explore fully the exciting possibilities that this approach presents for an effective attack on major social and economic problems.

As we have done so often in our history, we must turn to the personnel and tools of the private sector to bring our public goals within reach. I hope that the business community will make the same kind of commitment to progress.

It is clear that business need not wait—and in many cases is not waiting—for Congress or the Executive Branch to take the initiative in bringing systems techniques to bear on public problems. A number of unsolicited proposals have been made, and if recent indications are any guide, there is much more going on in private industry than we know.

I have recently seen a proposal of the Sperry Gyroscope Company, a division of Sperry Rand Corporation, for a demonstration project to develop, program, and operate a Nassau County, New York, computerized welfare information center

[8] Roy E. Lave, Jr. and Donald W. Kyle, "A Systems Study of Transportation in Northeast Brazil" (Stanford, California, Institute in Engineering-Economic Systems, Stanford University, Report DPS–1, March 1966), p. 29.

which uses systems analysis techniques. Sperry has declared its willingness to pay a portion of the cost of the proposed center and is currently seeking government support for it.

The attractions for business in this field are several. First, there is the profit motive, and the federal government of course should make certain that its private partners are sufficiently compensated. Then there is the chance for large firms to diversify, and possibly find and open up new "civilian" markets. Finally, there is the opportunity to take maximum advantage of the heavy investment already made in manpower and equipment necessary for systems techniques. This is particularly important for companies holding substantial defense contracts; the war in Vietnam has only temporarily postponed problems of conversion from defense to civilian production.

Companies need not themselves acquire systems capability. By using team techniques, such as the one involving the Texas Transportation Institute and Raytheon, or through acquisition, the substantive and systems capability can be linked effectively.

It is conceivable that the potentially enlarging "public market" will mean more than government contracts and loans to American industry. Many commentators have speculated that private firms in the future might operate even such traditionally public services as refuse collection and educational institutions on a for-profit basis. We have recently heard support for Comsat-type organizations to tackle the problem of urban slums and to coordinate the increasingly complex set of business-government relationships.

Some of these developments are far in the future. They all involve an element of risk and a great deal of intellectual and physical reorganization. This is more true of government than of business because of the glaring deficiencies in the federal government's current capacity to deal with complex modern problems.

This brings us back to the problem of communication. If the new partnership is to be effective, social scientists must disabuse themselves of the notion that the business community lacks compassion; and business must demonstrate that it is as willing to work with social scientists as with generals.

As is clear by now, I do not see these new trends as a threat to traditional values. We will not be dominated by computers if we have sensitive men and women under wise supervision programming them. Nor will the new government-industry partnership lead to greater centralization. On the contrary, greater decentralization would be the product of putting more responsibility for decision making in private and local hands. Indeed, it is not even unrealistic to foresee big government getting smaller!

What is needed most of all is a willingness on the part of all sectors of our society to keep an open mind about the shape of the future. We have within our grasp the means to shape an American society with a quality to match its prosperity. Let us have the wit to use them.

Of Interest in Connection With This Article

"The accelerating rate of scientific and technological advance has permitted the levying of national requirements of fantastic complexity. Lunar exploration, though perhaps the most dramatic of these, is but one such complex system. What has all of this to do with the future of our great cities? What has it to do with the role of a civic-minded man who is a lawyer, a banker, a teacher, or a businessman can play in his community's future? Simply this. Much of what lies ahead is no mystery. We know much of what the future will bring in terms of problems. We know they will be big, complex and serious. And we know what many of them are. These problems represent the givens. We know they will be there—and we know they will overwhelm us if we do not find the means of coping with them. What we lack, thus far, is conviction that there is a means of getting hold of them. They seem so staggering in their size and complexity—so far beyond the capability of any single institutional segment of the community, public or private.

". . . And they are so interrelated that to proceed to try to solve any one of them in isolation from the others is often to create more problems than are solved by the effort. The dilemma thus presented has so far frustrated most efforts to come to grips with these problems. This condition of paralysis need not obtain. None of the . . . challenges lies beyond our already existing capacity for coping with them. The tools are already at hand; and included in those tools are not

only the technological capabilities but experience in systems management and systems analysis as well as proven patterns of joint public and private effort."

Karl G. Harr, Jr., President of Aerospace Industries Association, in a speech before the Rotary Club of Philadelphia, September 15, 1965.

Highlights of the Systems Analysis Questionnaire

By Dennis W. Brezina and Louise Becker, Science Policy Research Division, Legislative Reference Service, Library of Congress

Questionnaire on Systems Capability and Activity at the Regional, State, and Local Levels

During the last three years, a period which covers the 89th Congress and part of the 90th Congress, the Special Subcommittee on the Utilization of Scientific Manpower of the Senate Committee on Labor and Public Welfare has conducted four sets of hearings on the "systems approach". The purpose was to arrive at a legislative solution to the problem of expanding and implementing the use of systems analysis and related techniques in the domestic sector of our nation. The proposed legislation, designed to effect this extension, met with strong enthusiasm and support. As the hearings progressed the Subcommittee came to understand clearly the scope of present systems activities and the need for expanding and refining the activity at the Federal, regional, State, and local levels.

To supplement the information received at the hearings the Subcommittee, with the aid of the Science Policy Research Division of the Library of Congress, prepared a questionnaire on systems capability and activity that was sent to State governments, selected cities, and regional development groups. (Sample questionnaire appears as Figure 1) In the letter sent with the questionnaire Senator Gaylord Nelson, Chairman of the Special Subcommittee, noted that the intent was:

"... to gather comprehensive data on the current experience of our states and large cities with these techniques."

He went on to elaborate:

"... Efforts at defining "systems approaches" have not been very successful for the term covers a broad range of related concepts and techniques, from the Defense Department's refinement of performance budgeting concepts to the use of computers for information handling. The subcommittee, however, is particularly interested in techniques for the analysis of problems facing government and the development of alternative policies toward their solution. We are interested in finding out to what extent such analyses now are being carried out at the state and local level, who is doing them, how effective they are in helping with real problems and what experience at the local and state level suggests as the best way to proceed from here."

The questionnaire, despite minor limitations, succeeded in reflecting the systems capability of the responding States and cities.

Specifically the questionnaire identified:

1. The planning and program areas in which the systems approach was being used.
2. The type of performer: in-house or out-of-house group.
3. Source of support: Federal or other.
4. Function and position in governmental structure.
5. Degree of benefit: measurable, too early to assess, etc.
6. Total cost.
7. Possible approaches for new Federal legislation.

Of the 50 states, 22 cities and 5 regional development groups queried, 81% replied. The responses indicated a variety of activity from virtually nothing to accelerated efforts that were integrated into the decision-making process.[1] Regardless of present commitment, whether slight or significant, the attitude towards systems analysis generally was one of eagerness to move ahead. Intentions to create, develop, and refine capabilities as well as the desire to enter into cooperative efforts were reflected. This signifies a growing interest in developing new processes to achieve a higher quality government.

Highlights of the questionnaire follow. The data accumulated from the 46 active respondents of the 63 total respondents are presented here as three tables

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[1] Note: Absence of reply does not necessarily mean a lack of activity.

and one chart. While no final conclusions have been drawn, apparent trends may be noted.

FIGURE No. 1

SYSTEMS ANALYSIS QUESTIONNAIRE

I. Indicate whether a systems capability exists within your staff (in-house) or whether you rely on outside consultants (out-of-house):

	In-House	*Out-of-House*			
		Non-Profit	*University*	*Industrial*	*Fed. Gov't.*
MANAGEMENT ACTIVITIES					
1. Planning & Policies	------	------	------	------	------
2. Personnel Management	------	------	------	------	------
3. Interagency Activity	------	------	------	------	------
4. Mgt. Standards & Controls	------	------	------	------	------
5. Equipment Selection	------	------	------	------	------
6. Procurement Activity	------	------	------	------	------
PROGRAM AREAS					
7. Legislatures	------	------	------	------	------
8. Courts	------	------	------	------	------
9. Financial	------	------	------	------	------
10. Taxation	------	------	------	------	------
11. Education	------	------	------	------	------
12. Health and Hospitals	------	------	------	------	------
13. Crime and Corrections	------	------	------	------	------
14. Transportation	------	------	------	------	------
15. Urban Renewal & Growth	------	------	------	------	------
16. Science & Research Promotion	------	------	------	------	------
17. Natural Resources	------	------	------	------	------
18. Pollution Control	------	------	------	------	------
19. Parks & Recreation	------	------	------	------	------
20. Regulation of Commerce, etc	------	------	------	------	------
21. Labor & Manpower Services	------	------	------	------	------
22. Utilities & Enterprises	------	------	------	------	------
23. Welfare & Anti-poverty	------	------	------	------	------
24. Social Security and Veterans	------	------	------	------	------
25. Other	------	------	------	------	------

NOTE.—In answering questions II and V below, please use the numbers found in question I which denote specific management activities or program areas; for example, #18 is for pollution control. A maximum of 5 such areas may be indicated for each part of questions II and V.

II. In which types of activities (as listed above) does your in-house capability have sufficient size and experience to:

	List Nos. from Question I.				
A. Conceptualize systems requirements and a technical approach	------	------	------	------	------
B. Monitor the work of a design or implementing group	------	------	------	------	------
C. Analyze current conditions and design new approaches	------	------	------	------	------
D. Implement new procedures and techniques	------	------	------	------	------
E. Evaluate innovative projects and equipment use	------	------	------	------	------
F. Initiate corrective action as needed	------	------	------	------	------

76-510—67——24

III. How has your in-house capability been organized?

A. Special advisor for systems analysis or operations research_____ ______
B. Line department for systems (or program) development_____ ______
C. Assistant for Planning-Programming-Budgeting_____ ______
D. Computer programming group_____ ______
E. Automatic data processing facility_____ ______
F. Other_____ ______

IV. How much money has been spent during 1966 for systems analysis and design?

	A. In-house	*B. Out-of-house*
$0–100,000		
$100,000–250,000		
$250,000–500,000		
$500,000–1,000,000		
$1,000,000–2,500,000		
Over $2,500,000		

V. Referring to the list of activities contained in I. (above) how useful have the systems approach innovations proven to be?

A. Measurable benefit____ ______ ______ ______ ______ ______ ______ ______
B. Marginal benefit____ ______ ______ ______ ______ ______ ______ ______
C. Too early to assess_____ ______ ______ ______ ______ ______ ______ ______
D. Negative value_____ ______ ______ ______ ______ ______ ______ ______
E. Unknown___ ______ ______ ______ ______ ______ ______ ______

VI. Federal legislation should provide your government establishment with support through:

A. Consulting services_____ ______
B. Direct financial subsidy_ ______
C. Matching funds_____ ______
D. Training support_____ ______
E. Enabling legislation_____ ______
F. Other_____ ______

Chart No. 1, "Indications of Systems Analysis Capability by Function," depicts State and local groups engaged in systems analysis activity and distinguishes between those activities that are served by in-house capability, out-of-house (e.g., contractor personnel), or both. The level of activity of each respondent and program category is indicated. (NOTE.—Only respondents that indicated activity on the Systems Analysis Questionnaire are included.)

CHART No. 1.—*Indications of systems analysis capability by function*

[X—In-house capability; Y—out-of-house and in-house capability; Z—out-of-house capability]

STATES	Planning and policies (1)	Personnel management (2)	Interagency activity (3)	Management standards control (4)	Equipment selection (5)	Procurement activity (6)	Legislatures (7)	Courts (8)	Financial (9)	Taxation (10)	Education (11)	Health and hospitals (12)	Crime and corrections (13)	Transportation (14)	Urban renewal and growth (15)	Science and research promotion (16)	Natural resources (17)	Pollution control (18)	Parks and recreation (19)	Regulation of commerce, etc. (20)	Labor and manpower services (21)	Utilities and enterprises (22)	Welfare and anti-poverty (23)	Social security and veterans (24)	Other (25)
Alaska	Y	X	X	X	X	X	----	X	X	X	X	X	X	X	----	----	X	----	X	----	X	----	X	----	
Connecticut	X	X	X	X	X	X	X	X	X	----	X	X	X	X	----	----	----	----	X	----	----	----	X	X	
Delaware	X	----	X	----	X	Z	Z	Z	X	X	X	X	X	X	Y	X	Z	Z	Z	Z	Z	Z	Z	Z	X
Florida	X	X	X	X	X	X	X	----	X	X	X	X	X	X	----	X	----	----	X	X	X	X	X	X	
Hawaii	Y	----	X	----	----	----	----	----	X	Y	Z	X	Z	X	----	Y	Y	X	X	----	X	Z	X	----	
Illinois	----	Z	----	Z	X	X	----	----	X	X	X	X	X	----	----	----	X	----	X	----	X	----	X	X	
Iowa	X	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Kentucky	----	X	----	----	X	X	----	----	X	X	Y	X	----	Y	----	----	----	----	----	X	----	----	----	X	
Maryland	X	X	X	----	X	X	----	----	Y	----	X	Y	X	X	Y	Z	X	----	X	----	----	----	X	----	
Massachusetts	X	X	Y	X	X	X	X	X	X	X	Y	X	Y	Y	X	Z	Y	Y	X	X	X	X	X	X	
Missouri	X	----	X	X	X	X	Z	----	X	Z	Y	X	Y	Z	Z	Z	X	X	X	Z	Z	X	X	Z	X[1]
New York	Y	Y	X	Y	Y	X	X	X	Y	Y	Y	X	Y	Y	X	X	X	X	X	X	Y	X	X	X	
North Carolina	Y	Z	Y	----	X	----	----	Y	X	X	Y	X	X	Y	----	Z	----	----	Z	----	Y	----	X	----	
North Dakota	X	X	X	X	X	X	----	----	X	X	Y	----	----	----	----	----	----	----	----	----	X	----	X[2]	----	
Ohio	X	X	X	----	X	----	X	----	X	X	X	X	X	X	----	----	X	----	----	X	----	----	X	----	X[3]
Oklahoma	Z	----	----	----	----	----	----	----	X	X	X	----	----	----	----	----	----	----	X	----	X	----	X	----	
Pennsylvania	Y	X	X	Y	Y	X	----	----	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	X	Y	Y	Y	Z	
Rhode Island	X	----	----	----	X	----	----	----	X	X	X	Y	----	Y	----	----	----	----	----	----	----	----	X	----	
South Dakota	----	X	----	----	Z	X	----	----	Y	X	X	----	----	X	----	----	----	----	----	----	----	----	----	----	
Texas	Y	Y	Y	Y	X	X	Y	----	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Utah	X	X	Y	Z[4]	X	X	X	----	X	X	X	X	X	X	----	----	X	X	X	----	X	----	X	X	
Washington	Y	Y	Y	X	X	X	----	----	X	X	X	Y	X	Y	----	----	X	X	----	X	X	X	X	X	X
West Virginia	Y	----	X	Y	----	----	----	----	X	----	X	X	X	Y	----	----	Y	----	Y	Y	----	----	----	----	
Wisconsin	X	X	X	Y	Y	X	Y	----	X	X	X	X	X	Y	----	Z	X	----	X	X	X	Y	Y	X	
Wyoming	X	X	X	----	X	X	X	X	X	X	X	X	X	----	----	----	X	----	X	----	X	X	X	X[5]	

See footnotes at end of table, p. 366.

CHART NO. 1.—*Indications of systems analysis capability by function*—Continued

[X—In-house capability; Y—out-of-house and in-house capability; Z—out-of-house capability]

	Planning and policies (1)	Personnel management (2)	Interagency activity (3)	Management standards control (4)	Equipment selection (5)	Procurement activity (6)	Legislatures (7)	Courts (8)	Financial (9)	Taxation (10)	Education (11)	Health and hospitals (12)	Crime and corrections (13)	Transportation (14)	Urban renewal and growth (15)	Science and research promotion (16)	Natural resources (17)	Pollution control (18)	Parks and recreation (19)	Regulation of commerce, etc. (20)	Labor and manpower services (21)	Utilities and enterprises (22)	Welfare and anti-poverty (23)	Social security and veterans (24)	Other (25)
CITIES																									
Atlanta, Ga	X	X	X	X	Y	X		X	X				X		X						X	X			
Baltimore, Md	Y	Y	Y	X	X	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	X	Y	Y	Y	Z	X	X	Y	Y	
Buffalo, N.Y	X	X	X	X	X	X	X	X	X	X	Y		Y		Y			Y	Y		X	X			
Chicago, Ill	X	Y		Y		X			X			X	X	X	X			Y			Y	Z			X [6]
Cincinnati, Ohio	X	X	X	X	X	X			X	X			X	Y	X			Z	X						
Cleveland, Ohio		X		X					X	Z															
Denver, Colo	X	X	X	X	X	X		X	X	X		X	X	X	Z		X		X		X		X		X
Detroit, Mich	Z													Z	X										
Green Bay, Wis	Y [7]	X	Y [7]	X	X	Y [7]	Y [7]	X	Y [7]	Y [7]	Y [7]	X [8]	X					Y [7]	X	X	Y [7]	Y [7]	X [8]			
Houston, Tex								X		Y			X									X			X
Kansas City, Mo		X							X						Y										
Los Angeles, Calif	X	X	X	Y	X	X	X		X	X		X	Y	Y	Y			Y	Y	X	X	Y	Y		
New Orelans, La	X	X	X	X	X	X	Y	X	Y		X		Y	Y	Y	X	X	X	X		X	Y	Y	X	
New York, N.Y	X			X		X		X	X	X	X							X					X		X
Philadelphia, Pa	Y	Y	Y	Y	X	X	Y	Y	X	X	X	Y	X	Y	Y	X		X	X	X	X	X	X		
Phoenix, Ariz	Y	X	Y	X	X	X		X	X	X			Y	Y					Y			Y			
Pittsburgh, Pa	Y	X	Y	Y	X	X	X	X	Y	Y			Y		Y		Y						Y	X	
San Diego, Calif	X	X	Y	X	Y	X			X				Y	X	X			X	X			X			X
Seattle, Wash	Z													Z											
REGIONAL DEVELOPMENT ORGANIZATIONS																									
Mississippi Research and Development	Z	Z	Z	Z	Z	Z	Z	Z	X	X	Z	X	Z	Z	X	X	Z	X	X	X	X	X	X	X	
Port Authority of New York	X	Y	X	X	Y	Y			X					Y	X			Y			X	X			X

[1] Information systems.
[2] Welfare only.
[3] Highway.
[4] In-house capability being established.
[5] Veterans only.
[6] Building code enforcement.
[7] Green Bay Industrial Authority activity included.
[8] Health only.

Table No. 1, "Percentage of Active Respondents Employing the Systems Approach by Function," condenses the data displayed in Chart No. 1. The 24 programs are grouped into 5 broad functions. They are arranged in descending order of involvement. (The percentage figures here are based on the number of respondents engaged in a specific program as compared to the total number of active respondents.) The systems approach is used most frequently in management and related activities (77 percent) while legal and regulatory functions apparently are areas of least activity (40 percent.)

Table No. 2, "The Level of Activity of States and Cities Engaged in Systems analysis," groups the states and cities according to the numbers of functions in which the systems approach is used. It shows a contrast between the two types of governing bodies. The states are concentrated either at a high or moderately high level of activity or they are concentrated at a low level of activity. The opposite is true for the cities where clustering is around the moderate level of activity.

Table No. 3, "Funds Expended on Systems Analysis," displays the reported expenditures to each state, city and regional development group for their systems activities. The states are separated from the cities and regional groups.

TABLE No. 1.—*Percentage of active respondents employing the systems approach by function. (46 active respondents)*

I. Management and related activities—overall percentage	77
Planning and policies.	
Financial.	
Equipment selection.	
Personnel management.	
Taxation.	
Procurement activity.	
Interagency activity.	
Management standards and control.	
Overall percentage.	
II. Services and transportation—overall percentage	60
Transportation.	
Utilities and enterprises.	
Overall percentage.	
III. Social and economic development—overall percentage	57
Crime and correction.	
Education.	
Welfare and anti-poverty.	
Health and hospitals.	
Urban renewal and growth.	
Pollution control.	
Social security and veterans affairs.	
Overall percentage.	
IV. Utilization of resources—overall percentage	51
Parks and recreation.	
Labor and manpower services.	
Natural resources.	
Science and research promotion.	
Overall percentage.	
V. Legal and regulatory—overall percentage	40
Legislatures.	
Regulation of commerce.	
Courts.	
Overall percentage.	

TABLE No. 2.—*Number of States and cities engaged in systems analysis efforts by level of activity*

Level of activities	Number of States	Number of cities
High level (20 to 25 program areas)	9	5
Moderately high level (15 to 19)	7	3
Moderate level (10 to 14)	4	7
Low level (1 to 9)	5	4

TABLE No. 3.—*Funds expended by States and cities on systems analysis in 1966*

States:	
1. New York	[1] $4,250,000
2. Oklahoma	[1] 1,800,000
3. Pennsylvania	[1] 1,125,000
4. Wisconsin	[1] 550,000
5. Connecticut	[1] 375,000
6. Maryland	[1] 350,000
7. Massachusetts	[1] 350,000
8. Texas	[2] 350,000
9. West Virginia	[1] 350,000
10. Alaska	[2] 260,000
11. Rhode Island	[1] 225,000
12. Kentucky	[1] 225,000
13. Missouri	[1] 175,000
14. Florida	[1] 175,000
15. Utah	[1] 175,000
16. Washington	[1] 100,000
17. South Dakota	[1] 100,000
18. North Dakota	[1] 50,000
19. Wyoming	[1] 50,000
20. Delaware	[1] 50,000
21. Iowa	[1] 50,000
22. Ohio	[2] 7,500
23. Hawaii	([3])
24. Illinois	([3])
25. North Carolina	([3])
Subtotal	11,142,500

Cities and regional groups:	
1. Baltimore	[1] $2,675,000
2. Philadelphia	[1] 2,500,000
3. Port Authority of New York	[1] 1,975,000
4. Los Angeles	[1] 1,975,000
5. New York City	[1] 800,000
6. Chicago	[1] 550,000
7. Mississippi Research and Development Center	[1] 375,000
8. Cincinnati	[2] 310,000
9. San Diego	[1] 225,000
10. Denver	[1] 175,000
11. Pheonix	[1] 100,000
12. Atlanta	[1] 100,000
13. Detroit	[1] 100,000
14. Kansas City	[1] 100,000
15. New Orleans	[1] 100,000
16. Houston	[2] 66,000
17. Cleveland	50,000
18. Buffalo	([3])
19. Pittsburgh	([3])
20. Green Bay	([3])
21. Seattle	0
Subtotal	11,326,000
Grand total	22,468,500

[1] Estimated average figure.
[2] Stated figure.
[3] Not indicated.
[4] Not available.

WASHINGTON, D.C., *January 30, 1967.*

Re S. 430 and S. 467.

Hon. GAYLORD NELSON,
Chairman, Special Subcommittee on Scientific and Technical Manpower,
Committee on Labor and Public Welfare,
U.S. Senate, Washington, D.C.

DEAR SENATOR NELSON: In response to your invitation I should like to submit my comments on S. 430 and S. 467. Your committee has been performing important work through its efforts at grappling with the major problems of our technological society, how to harness technology to fulfill the commandment "replenish the earth and subdue it."

Enclosed is a copy of my study proposal, "Creative Federalism, Public-Private Collaboration, and National Needs in Research and Development", which I should like to submit for the record. The thesis is that research and development using the "system approach" requires appropriate institutions on the national level in order (a) to develop national programs in the problem areas of "education, unemployment, welfare, crime, juvenile delinquency, air pollution, housing, transportation, and waste disposal", (b) to select the research and development resources, and (c) to evaluate the progress of the program. It is

the thesis that a successful institution coping with public-private problems and with governmental jurisdictional problems already exists as a model for new institutions.

To be consistent with my paper, I shall have to assert that S. 430 is premature because the institutions to manage effectively the pursuit of its worthwhile purposes do not yet exist. I would therefore not favor its enactment at this time.

On the other hand S. 467 proposes to study the needs for and the characteristics of such institutions. My paper proposes a study program such as the Commission might wish to procure. $500,000 is certainly more than adequate to operate the Commission and to procure such a study during the first year. Thirty months seems adequate to reach conclusions which would make S. 430 timely.

A Commission of this importance calls for individuals experienced in R&D management. Outside the government they typically receive compensation in excess of $150 per diem. An increase of the allowance in S. 467 from $75 per diem to the $100 per diem authorized in H. R. 20 would seem to be in the national interest.

I would recommend adding in Section 1 of S. 467 after the word "education" in line 7 the words "air pollution, housing, transportation, waste disposal," and would favor enactment of the amended bill.

Most respectfully yours,

JAMES B. HODGSON, Jr.

Enclosed: Study Proposal.

CREATIVE FEDERALISM, PUBLIC PRIVATE-COLLABORATION AND NATIONAL NEEDS IN RESEARCH AND DEVELOPMENT

By James Hodgson, Consultant, Operations Research, System Engineering, Washington, D.C.

ABSTRACT

This paper examines, first, organizational measures by which the federal government can foster the effective guidance of research and development efforts within both its direct and indirect concern, and, second, ways through which the federal government (cooperating with the other governmental levels and the technical community) can further encourage the support of research and development in these areas by non-appropriated funds through various tax incentives.

It uses the successful experience of the Highway Research Board under the National Academy of Science and the National Research Council during the last forty years at enlisting the efforts of government officials at all levels, of academic personnel and laboratories and of industry in general in a broad program.

It proposes a study to analyze the useful lessons and apply them to critical problem areas such as transportation, communication, information, environment design, pollution control, education, and societal engineering.

THE PROBLEM

As technology progresses it becomes increasingly apparent that the federal government is becoming a more active partner with the academic and technical community and with industry. Resources are continually being exploited and strained whether it be a mineral and biological resource, space, pure air and water, capital, organization, or brain-power and talent. Classic economic principles of competetive distribution become less attractive as the sole regulatory device, even when ameliorated by tax stimulated endowments; however, neither has centralized regulatory authority proven to be a flexible, creative influence.

The federal government has shown increasing concern for discovering national needs for research and development, for guiding the technology into more fruitful paths, and to overcome some of the developing crises before they reach the acute stage. There are many such crises: the information explosion, the transportation mess, urban sprawl, environmental pollution, education, and public welfare, to name only a few. Since the establishment of the National Academy of Science by Congressional charter under President Lincoln and the organization of the National Research Council under President Wilson, there has been

a proliferation of public agencies and organizations which have devoted direct attention to performing or sponsoring or at least to providing stimulus and guidance to the technical community engaged in research and development.

As the technology has developed and the industrial establishment has become more complex and all embracing, the adoption and enforcement of industrial standards and specifications has become increasingly difficult and critical. Governmental agencies can adopt such standards for items of government purchase, but frequently these standards do not achieve industrial acceptance. Recent notable examples have occurred in motor vehicle safety and air and water pollution. Standardization in information processing has only been achieved where a single commercial corporation has dominated. The imposition of standards by executive fiat meets great legislative resistance despite the urgency of solutions.

CONSTRAINTS ON SOLUTIONS

The basic constraints on any effective solution to these problems stem from the need to take two trends into account: (1) the interest and demand for creative federalism and (2) the need for public-private collaboration.

To be effective any solution must provide for a flow of information and advice to and from the expert segment of the community and must link it openly and professionally with the executives and the resources which guide research and development efforts.

Any centralization of responsibility on an executive authority in the federal government (except for the spending of federally appropriate R&D funds) meets with natural opposition from state, regional, and local governmental and from industrial sources. The designer of a structure to solve this problem must provide for a broadening of the councils and an organizational flexibility which can accommodate to shift of influence. At the same time the organization must not interfere with the effective and responsible operation of governmental agencies charged with R&D management.

Any proposed solution which does not foster and stimulate R&D activity in the private sector (and especially the generous flow of private capital into R&D) will be plagued by the instabilities of the political process. It must result in collaboration between the various public and private agencies at all phoses of the R&D cycle.

HYPOTHESIS

This paper suggests as an hypothesis that the Highway Research Board has a unique set of characteristics which make it a model for the organizational invention required to foster and guide research and development in a broad spectrum of applications or problem areas. HRB has been a major reason for the success of the US highway programs over the last half century (and, ironically, a cause of the current transportation crisis), and suggests that it be studied together with other vehicles for managing research and development, that these studies then be extrapolated to the proposed problem areas, and that the alternatives be evaluated from the aspects of cost-effectiveness, including encouragement of private support, furtherance of research and development programs, and effectiveness and success in obtaining the advice of mature judgment and encouraging bold innovation—in getting the Old Hands and the Young Turks into the same panels. It suggests that the other mangaement methods have flaws and fail to satisfy all of the constraints.

THE HIGHWAY RESEARCH BOARD AS A MODEL R&D COORDINATION VEHICLE

Among the important characteristics of the Highway Research Board appears to be the fact that it wears the mantle of prestige of the National Academy, but at the same time is open to membership from individuals with some competence, responsibility, or interest in its areas of concern. It has greater prestige than comparable professional societies (or than the Building Research Institute, a sister organization which was spun off from the Academy in 1962) and also has official status as an advisor to the federal (and state) government. Furthermore, it provides a vehicle for merging funds and interest from both the public and private sectors into a coordinated research and development program and can enlist the best (and donated) efforts of the scientific and technical community on a continuing basis.

If we define the research and development cycle as including the following five phases—program definition, task definitions, budgeting, contract management, and reporting—then the HRB model shows a way of achieving a high

degree of participation in each. In *program and task definition* it provides a forum for encouraging discussion and probing, the analysis and recognition of needs for research and development. In *budgeting* it can aid legislators, administrators, and workers by evolving priorities among various program and task phases. It can aid *contract management* by providing the public forum where contract managers are exposed to the scientific and technical community, where capable ones can achieve professional recognition, obtain technical guidance and advice. Both through its committee structure and its publication and information service programs and meetings, it serves *reporting* by disseminating the results of research and by furnishing a forum for the critique of these methods and results and the correlation of the findings and achievements into the body of scientific and technical knowledge and experience.

These functions, it may be argued, are currently served by the professional societies, by general problem oriented conferences, by the literature, by the National Academy and its advisory committees, by other advisory committees appointed by executive agencies charged with R&D responsibility, and by the accumulation of expertise in executive agencies and in their government laboratories.

The justification for the proposed study is that all of these vehicles lack one or another of the proposed desirable characteristics exemplified by the Highway Research Board. The *professional societies* have only academic authority, and they can be sometimes convicted of professional bias. *General problem oriented conferences* may aid in program and task definition and reporting; but unless they have a permanent secretariat, they depend primarily on the sponsor for any impact. The *public literature* may aid both contract management and reporting, but is a very unresponsive, conservative forum. The weakness of the *Academy* lies in the vastness of the demands made on its limited membership. The Academy is not a forum where, to quote the Executive Director of the Highway Research Board, "Old Hands are jacked up by Young Turks, and Young Turks are knocked down by Old Hands." The innate tendency of academies is conservative, and the wide demands on the time of the members precludes adequate study of any but the most crucial problems. Similarly the difficulties with *advisory committees* appointed by governmental agencies (whether the members are remunerated or not) lies in the sometimes inadequate preparation of the members, and inbred and nurtured biases. The danger of biases which reinforce each other is ever present in *executive agencies* and their *government laboratories* (and in academic institutions and industrial laboratories too) when they themselves manage or perform research and development.

It is very difficult to achieve the desirable balance between openness to innovation and critical rigor within any organization except where the controlling dynamics are the scientific and technical self-discipline of the public forum; but this characterizes the strength of the Highway Research Board. The advantages of its structure and position within the framework of the National Academy of Sciences and National Research Council have been characterized by William N. Cary, Jr., its Executive Director, as follows:

1. As a subsidiary of the NAS-NRC, the HRB prestige is adequate to achieve full participation by the academic community. Deans view participation by their faculties as a worthy academic function.

2. The management structure of the Academy and NRC provides a substantial insulation against the pressures of member and contributor organizations, whether they be professional societies, government and industrial bureaucries, or stockholder interests. The term "Highway" in the Board's name has been a problem more because of its restrictive implications than because of nefarious pressures from highway interests.

3. Since moneys can be transferred by the agencies of the federal government to the National Academy of Science—National Research Council with fewer and loose management controls than permitted by other federal contracting procedures, programs can be funded and managed more expeditiously.

DESCRIPTION OF THE HRB

The Highway Research Board was organized in 1920 as the Highway Advisory Board "to secure cooperation among existing agencies, to coordinate their work into a national research program, and to make results widely available, so as to put road-building on a scientific, engineering, and economic basis." It has since achieved wide participation by the academic community, members of industry, and government officials. There are currently 1700 individual sup-

porting members and some 175 organizational members. The membership is quite unrestrictive in that "Individual Supporting Members . . . may be persons engaged in research relating to highways or transportation, or whose activities are educational in character, or who are simply interested in technical development. Such membership is subject to approval by the Executive Committee and the affiliation remains in effect as long as dues are paid or until termination through resignation or by the Executive Committee." The fee of $25.00 annually covers primarily the cost of publications distributed to members such as *Highway Research Abstracts, Highway Research News*, and those in the members interest area from the large number of special publications. Organizational Supporting Membership categories include federal, state, and local governmental membership, educational and research institutions, professional societies, service organizations, transportation agencies, trade associations, industrial and consultant memberships, and foreign governmental and foreign non-governmental memberships.

The structure of the HRB permits it to undertake limited studies with its own staff, and to supervise contracts. It organizes annual meetings, and by its committee structure aids in problem finding, research program review, program definition, and the criticism and dissemination of research results. A major function is the Research Correlation Service which has at its dsposal an automated highway information system.

The regular program services fit within an annual budget of roughly $1.5 million of which some 27% represents overhead charges which are consolidated under NRC administration. In addition HRB administers the $3 million National Cooperative Highway Research Program. The FY 1968 budget for the regular functions of the Board will reach $1.567 million with $957,000 contributed by the various State Highway Departments, $323,000 from the Federal Bureau of Public Roads, plus $287,000 miscellaneous funds representing membership dues and the proceeds from the sale of publications. The NCHRP administered by the Board is funded out of the 1.5% research funds authorized the states under the Interstate Highway Program. The NCHRP comprises about 75 projects. The dollar value of contracts awarded by HRB has been distributed 44% to universities, 25% to non-profit institutes, 23% to consulting firms, 7% to commercial firms, and 1% to industrial firms.

NRC SISTER ORGANIZATION

There are many other committees, board, organizations, etc., which are supervised by the National Research Council. Among these are several interdisciplinary boards funded by the National Science Foundation, such as the Geophysics Research Board in the Office of International Relations and the Pacific Science Board and the Space Science Board. The only two organizations, however, which receive substantial support from the private sector of the economy have been the Highway Research Board and (prior to its dissociation from NAS–NRC in 1962) the Building Research Institute each of which then received dues in a value of about $100,000.

SIGNIFICANCE OF THE CONCEPT

Public, industrial, and government concern for research and development in scientific and technological fields has been growing rapidly as reflected by the many conferences, meetings, articles, projects, and congressional hearings. [See Senate Committee on Government Operations, *An Inventory of Congressional Concern with Research and Development*, 1966.] More direct reliance is being placed by both the executive and legislative branches of the federal government on scientific advice in developing policies to cope with incipient crises in transportation, environmental pollution, education, and social and economic structure. The Highway Research Board is unique among the public bodies which have been providing consultation either directly to the Congress or indirectly through the creation of a forum by which the congressional witnesses have received their prior education, and by exploitation of the forum have evolved generally acceptable legislative proposals. The Highway Research Board has had almost unnoticed success. It has achieved construction cooperation despite the diversity and conflict of interests among different federal agencies, among federal, state and local counterpart agencies, between government agencies and industry, among the various disciplines involved in transportation, and most re-

cently even between the proponents of rail and highway transportation modes so that "integrated transportation systems" are actually reflected in plans and programs.

At a time when the new Departments of Housing and Urban Affairs and of Transportation are embroiled in the solution of the dilemma of the charter for support of rail transportation research and development, the Highway Research Board concept (perhaps as a Guideways Research Board) suggests solutions to many of the charter problems.

Similarly water and air pollution have been recognized as an oncoming crisis with a technological basis and a need for research and development. The problems, however, cut across the lines of such diverse Departments as Health, Education and Welfare, Housing and Urban Development, Transportation, Interior, Agriculture, and Commerce. There is a jealous guard in every locality and region and every industry against federal controls. So complex is the problem and so divergent are the opinions and so little is known that the congressional committees who bear the responsibility for legislation find it necessary to review research and development, to perform technological forecasting, to assess economic impact of proposed alternatives. This is an infeasible procedure which is saved from disaster only by the personal commitments of the legislators and their staffs and witness to work for a satisfactory compromise among the myriad of conflicting interests and concerns.

Information processing and documentation technology has been exploding into anarchic self-defeat. Attempts at setting industry or government standards for programming languages or equipment have been scarcely more successful than bowing to the acknowledged industrial leader. Applications in libraries, abstracting service, "management information systems", etc., have run into complex standardization and development management problems affecting virtually every business and government agency and academic institution.

In view of the current interest at the federal level in organization studies prompted by the establishment of two new cabinet level departments, the reorganization of HEW, and the activity by the Bureau of the Budget in establishing the Planning, Programming, and Budgeting system throughout the executive branch of the government and the special attention now being devoted to PPB controls over research and development moneys and programs, a study to review the experience of the Highway Research Board and to extrapolate this experience to the comparable problem areas seems appropriate.

PROPOSED STUDY OUTLINE

It is proposed that the problems outlined above be examined under the direction of the Director of the Budget and the President's Science Advisor on a federal scale. It is suggested that the study be limited to examining research and development in the applications oriented (rather than discipline oriented) mode. It is proposed that this study exclude consideration of basic, discipline-oriented research such as is sponsored by the National Science Foundation.

Objective.—To improve the effectiveness of research and development in relationship to applications orientation in areas critical to the national interest, but not sensitive to considerations of national security in the military sense, or in the usage of the Department of State.

Scope.—To analyze and describe experience of the federal government and the National Academy of Science and similar organizations in the review and management to research and development programs in such applications areas as transportation, communications, information technology, pollution control, education, and social and economic structure, to evaluate the strengths and weaknesses of the various organizations and methods, to make recommendations as to the alternatives and preferences, and to outline methods of implementation.

Phase I.—A Concept Study to Characterize and Compare R&D Management and Review Methods Open to the National Establishment.

Task I: Characterize and identify R&D management and review methods: [Examples]

a. Bureau review and management.
b. Bureau review supported by appointed committees of experts serving either with or without compensation; Bureau Management.
c. NSF committee review, NSF management.
d. NAS–NRC committee review, Bureau management
e. Board review and management

Task 2: Compare each method reported under Task 1 and evaluate for the following:

a. Ability to recruit (and cost) from the scientific and engineering community measured by representation as a function of personal prestige, competence, and openness to significant participation by "young Turks" and to innovations.

b. Impact on programs (considering charters, missions, procedures, motivations of participants from various levels of government, industry, and the general public.

c. Funding techniques and resources including tax incentive structures, potential rate benefits, etc.

d. Program scope and development (innovation and project definition, planning functions, review methods, authority and executive functions including ability to redirect efforts, cancel, etc.)

e. Management structures and relationships.

f. Legal and fiscal basis.

Phase II.—An Implementation Study (addressed to one or more of the above methods in technological or applications areas as authorized by the client)

Task 1: Goal definition:

a. Current and desired frameworks.

b. Organizational structure.

c. Operating rules.

d. Charter and Legislative requirements.

Task 2: Development plan, phases, and milestones:

a. Financial plan.

b. Personnel plan (staff and public membership).

c. Organizational plan (including charter, etc.).

d. Technical plan.

e. Public information plan.

APPENDIX

A Guideways Research Board

(An organizational example)

BACKGROUND AND FRAMEWORK

The notion of a Guideways Research Board was chosen to illustrate the concept of this paper for a number of reasons. First, expansion in the direction of guideways research is already a desire of the Highway Research Board. Second, there is an interdepartmental problem between the Departments of Transportation and of Housing and Urban Development which could be alleviated by such a Board. Third, until national legislation from 1962 to 1965 supporting rail and rapid transit development came about, rail technology research and development was embarassingly retarded in comparison to European and especially Japanese work. Fourth, the economic structure of the rail transportation industry and its impact on the overall economy makes it a particularly likely candidate to illustrate public-private collaboration. The industry has been slow about research and development but can afford a very substantially funded program.

The proposed Board is chosen only as an illustration of the principle. It might be preferable actually to rename the Highway Research Board replacing it with a Transportation Research Board, or at least with a Land Transportation Research Board, and simply evolve along the general lines sketched herein. The analogies which can be drawn between the highway and the rail industries make it easier to extrapolate a suggested organization than in the more complex application areas of environmental pollution or education.

The proposed Guideways Research Board would function like the Highway Research Board under the Engineering and Industrial Research Division of the National Research Council. The National Research Council was organized in accordance with Executive Order #2859, issued by President Wilson, May 11, 1918, and amended by President Eisenhower, May 10, 1956. Its functions include "(a) In general, to stimulate research in the mathematical, physical and biological sciences, and in the application of these sciences to engineering, agriculture, medicine, and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare.

"(b) To survey the broad possibilities of science, to formulate comprehensive projects of research, and to develop effective means of utilizing the scientific and technical resources of the country for dealing with such projects."

The National Research Council is administered by a chairman who is appointed by the Council of the National Academy of Science. The Executive Board of the NRC includes the chairman and officers of NRC, the chairmen of divisions, and ex officio the members of the Executive Committee of the Council of the NAS. This NAS Council Executive Committee consists of seven members including the President of the Academy, the Vice-president, the Chairman of NRC (providing that he is also a member of the Academy), the home secretary of the Academy, the treasurer, and other members of the Council as appointed by the President. [Article II, Section 9 of the Constitution of the NAS states: "Pursuant to the Executive Order issued by the President of the United States, May 11, 1918, and with the duties therein specified, the Academy shall perpetuate the National Research Council."]

The NRC is divided into the Office of International Relations, Divisions of Physical Science, Mathematics, Engineering and Industrial Research, Biology and Agriculture, Anthropology and Psychology. If the proposal were carried out, The Highway Research Board and the Guideways Research Board would belong in the Division of Engineering and Industrial Research.

SCOPE

The proposed Guideways Research Board would be a cooperative organization of rail and rapid transit officials, technologists, economists, urban planners, industrialists, scientists and engineers operating under auspices and general management of the NRC. Members would include officials of the Departments of Transportation, of Housing and Urban Development, of Health, Education, and Welfare, of Commerce, and of Agriculture together with members of regulatory agencies, of state, regional and local transportation boards, authorities, and agencies, of private transportation companies (operators and suppliers), of user and trade associations, and of professional and service organizations interested in transportation systems.

The Board would be empowered to receive, administer, and disburse public and private funds for its legitimate operating purposes, for endowments, and for the support of technical projects in furtherance of its purposes.

The GRB would be restricted to considering research and development in problem areas related to the location, design, construction, operations, maintenance, promotion, and organization of guideway transportation systems near or on the surface of the earth.

PURPOSE

The purpose of the Guideways Research Board would be to—

1. Provide a forum for the discussion of guideway transportation problems.
2. Identify and specify requirements for research and development related to guideways.
3. Correlate and disseminate the results of research and development related to guideways.
4. Provide consulting services to requesting organizations in support of or in supervision of research and development programs.
5. Provide consulting services toward the formulation of national transportation policy.
6. Administer and supervise such research and development projects as are authorized it under the guidelines of the National Research Council and following the administrative and contracting procedures of the National Research Council.

SOURCES OF SUPPORT

The sources of funds available to the Board for its regular operating expenses and to support projects will include public grants, membership fees, and contributions toward research and development projects from industrial organizations and trade associations, stimulated by tax and rate considerations. Direct support of specific projects by project-specific grants would be acceptable according to the guidelines and standards of the NRC. It should be noted that the Bureau of the Budget permits less detailed bookkeeping and controls on federal funds granted through the National Academy than normal procurement demands.

ORGANIZATION

The participants in the Guideways Research Board would be either Individual Supporting Members or designated representatives of Organizational Supporting Members. Organizational members would include federal, state, regional, and local, and foreign transportation and planning agencies, academic institutions, industrial and consulting firms, and transportation operating firms and agencies, and trade, service, and professional membership organizations. Membership would be on application of qualified personnel and on approval of the Executive Committee of the Board.

The Executive Director, a fulltime paid post, would be a member ex officio of the Executive Committee. His appointment would require confirmation of the Executive Board of the National Research Council. A paid permanent administrative and technical staff would be authorized under the budget of the Board, approved by the Executive Board of the NRC. This staff would support the research correlation and information service and provide a permanent secretariat to the Departments, Divisions, and Committees of the Board.

The members of the Board would be assigned to departments in accordance with their general interests and backgrounds; a possible list of departments follows:

Economic Engineering Department.—economic, financial and administrative studies, operations research, regional planning, route planning principles, safety and performance analysis, test planning and standards, political and sociological analysis and demography, public relations and motivational research, market analysis methodology, and total systems engineering.

Electrical, Chemical, and Mechanical Engineering Department.—vehicular and rolling stock design and standards including maintenance and construction equipment, propulsion and power generation and distribution, braking, guidance and control, traffic control, passenger and freight handling, communications equipment, ticketing and management system equipment, comfort and safety standards and packaging and containerization standards, suspension system design and standards, aerodynamics and stability.

Architecture and Civil Engineering Department.—route planning consultation, geology, soils, road bed materials, guideway design and materials, overhead structures, bridging and tunnels, terminal design, air rights structure design, route architecture, noise and pollution control, construction equipment and techniques.

PROSPECTIVE NON-GOVERNMENTAL SUPPORT

The following list of trade and service associations is not exhaustive, but gives some indication of the structure of the industry being aided and from which contributions and support for the program of the Board could be sought.

American Transit Association, 355 Lexington Avenue, New York, N.Y. 10017.
Institute for Rapid Transit, P.O. Box 355, Merchandise Mart, Chicago, Illinois 60634.
Association of American Railroads, Transportation Building, Washington, D.C. 20006.
American Railway Car Institute, 200 East 42d Street, New York, N.Y.
American Railway Development Association, 1103 C&O Building, Huntington, West Virginia.
American Railway Engineering Association, 59 East Van Buren Street, Chicago, Illinois 60605.
Railway Progress Institute, 38 South Dearborn Street, Chicago, Illinois 60603.
Railway Signal and Communications Suppliers Association, 30 Church Street, New York, N.Y. 10007.
National Association of Shippers Advisory Boards, Transportation Building, Washington, D.C. 20006.
National Industrial Traffic League, 711 14th Street, N.W., Room 909, Washington, D.C. 20006.
National Small Shipments Traffic Conference, 919 18th Street, N.W., Suite 266, Washington, D.C. 20006.
Transportation Association of America, 1710 H Street, N.W., Washington, D.C. 20006.
Institute of Traffic Engineers, 1725 De Sales Street, N.W., Washington, D.C. 20006.
Portland Cement Association, 33 West Grand Avenue, Chicago, Illinois 60610.

National Lumber Manufacturers Association, 1619 Massachusetts Avenue, N.W., Washington, D.C. 20006.
National Association of Home Builders, 1625 L Street, N.W., Washington, D.C. 20006.
Structural Clay Products Institute, 1520 18th Street, N.W., Washington, D.C. 20006.
Gypsum Association, 201 North Wells Street, Chicago, Illinois 60606.
Bituminous Coal Research Institute, Inc., 350 Hochberg Road, Monroeville, Pennsylvania.
National Coal Association, 1130 17th Street, N.W., Washington, D.C. 20006.
National Fuel Oil Institute, 60 East 42d Street, New York, N.Y. 10017.
Rubber Manufacturers Association, 444 Madison Avenue, New York, N.Y. 10022.
Manufacturing Chemists Association, 1825 Connecticut Avenue, N.W., Washington, D.C. 20009.
National Plant Food Institute, 1700 K Street, N.W., Washington, D.C. 20006.
National Livestock Producers Association, 155 North Wacker Drive, Chicago, Illinois 60606.
American Institute of Food Distribution, 420 Lexintgon Avenue, New York, N.Y. 10017.

Senator NELSON. That will conclude the hearing.

(Whereupon, at 12:35 p.m., the subcommittee was recessed subject to call of the Chair.)

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